Volume 4 ▪ Issue 4 ▪ February 2011

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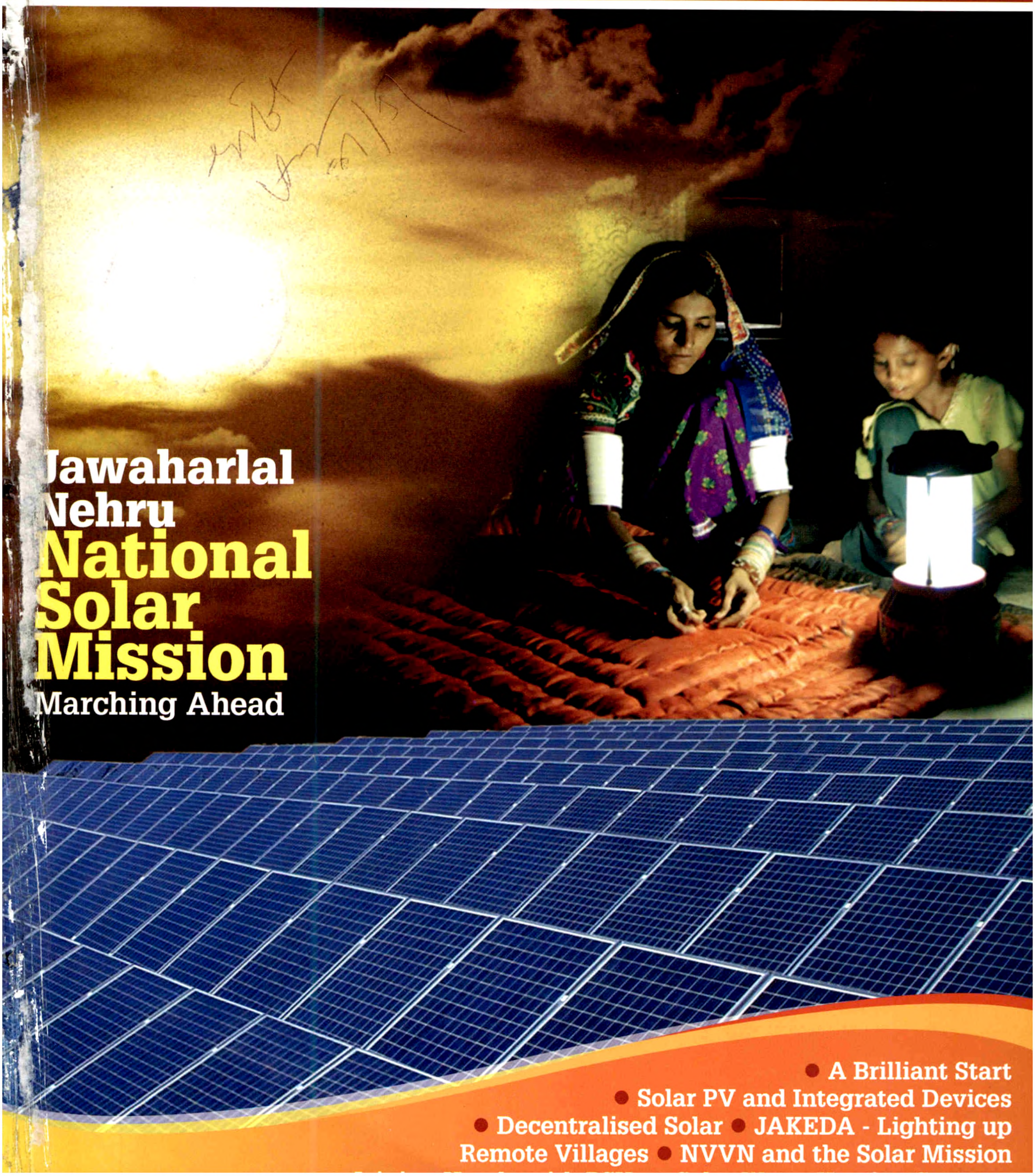
Ministry of New and
Renewable Energy
Government of India

Renewable Energy
Akshay Urja

www.mnre.gov.in



Jawaharlal Nehru National Solar Mission

Marching Ahead

- A Brilliant Start
- Solar PV and Integrated Devices
- Decentralised Solar
- JAKEDA - Lighting up Remote Villages
- NVVN and the Solar Mission

WORLD
RENEWABLE ENERGY TECHNOLOGY CONGRESS

21st - 23rd April 2011, Le Meridien New Delhi

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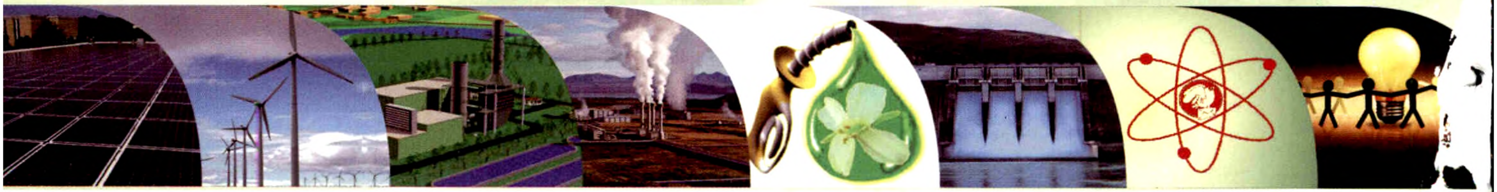

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21st - 23rd April, 2011
Le Meridien New Delhi India

Renewable Energy
Akshay Urja

Volume 4 ▪ Issue 4
February 2011

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India
(Published in English and Hindi)

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Produced by
Iris Publication Pvt. Ltd.
111/9 KG, Aruna Asaf Ali Marg,
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E-mail: ipplimited@yahoo.co.in
Web: www.geographyandyou.com

Publisher and Printer
Ministry of New and Renewable Energy, New Delhi

Cover Photo: Solar home lighting system making life easier for women.

Disclaimer: The views expressed by authors including those of the editor

From the Editor's Desk

P 34,457 CUK-H02144-2-P034457

Dear Readers,

It has been a year since the ambitious Jawaharlal Nehru National Solar Mission (JNNSM) was launched in January 2010 by the Government of India. Although the completion year of JNNSM is 2022 and a lot remains to be achieved, yet the past year with significant milestones warrants a succinct discussion.

The year 2010 also saw the release of two important JNNSM guideline documents by the Ministry of New and Renewable Energy (MNRE). The first, on 16 June 2010 was the release of the 'JNNSM Guidelines for off grid and decentralised solar applications and rooftop and other small solar power plants'. While the second was the release of the 'JNSSM Guidelines for selection of new grid connected solar power projects' document on 25 July 2010. These documents provided the impetus for the implementation of the National Solar Mission (NSM) in India .

With the basics in place it is now time to assess how the other pieces are fitting in - this issue is an introspection of the steps and efforts that are being undertaken by individuals, private organisations, the state and central government agencies et al, to make 'solar India' shine.

This issue of Akshay Urja will also update you on the progress so far of the JNNSM. It highlights the role of the NTPC Vidyut Vyapar Nigam Limited (NVVN) and the public sector undertakings (PSUs) in taking the JNNSM forward. Readers will also find articles on innovations in renewable energy as well as how the actual schemes under JNNSM are being implemented.

I hope you will find this issue interesting and informative. I invite all stakeholders and beneficiaries to share their views and experiences with us to help us expand the scope and reach of Akhay Urja.

As we leave behind the chill of winter we hope that the warm sun will usher in light into our lives and bring a smile to every face.

2

अक्षय ऊर्जा से देश विकास

AKTripathi

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Published, printed and edited for and on behalf of the Ministry of New and Renewable Energy, Government of India, from B-14, CGO Complex, Lodhi Road, New Delhi, by Dr Arun Kumar Tripathi. Printed at Aravali Printers & Publishers (P) Ltd. W-30, Okhla

Letters to the Editor

We have established a club called the Kalpana Chawla Science Club (KCSC). The club has a library with different science magazines. We came across Akshay Urja brought out by MNRE and feel that it can greatly help us in our club activities such as making technical models and projects related to renewable energy. We therefore request you to kindly send us the newsletter for our club library.

Varsh Wadhwani,
Secretary, KCSC,
Dhamtari, Chhattisgarh

Some students in our department are working on the topic 'Structural design of multistorey buildings' for a project. We would appreciate if you can publish some articles on 'energy efficient building' in your newsletter Akshay Urja.

Dr S S Quadri,
Hubli, Karnataka

My friends and I have learnt a lot from Akshay Urja. We find the newsletter very interesting and informative and we would all like to receive it.

Nitesh Bhardwaj
Jhansi, Uttar Pradesh

Congratulations for your efforts for bringing out Akshay Urja newsletter Volume 4, Issue 2 & 3.

Sandeep Garg,
Energy Economist,
BEE, New Delhi

I have been reading Akshay Urja and have found it very enriching and interesting. The articles cover a wide spectrum and are very informative. I hope you continue to do the great job.

Prof Harsh Vardhan
Associate Professor,
IILM, Gurgaon

I really appreciate the Akshay Urja newsletter because it enhances my interest in studying more about new, renewable and alternate energy as well as energy efficiency. It helps me keep up with new information about our fast changing world, particularly knowledge about recent developments in the field of energy sources that are non carbon based. Please keep exploring innovative areas of research and keep up the good work.

Muktikam Phukan,
Joint Director (FA), PCRA
New Delhi

Thank you very much for this nice newsletter, Akshay Urja, Vol 4, No 2 & 3.

P K Sundaram,
Senior Research Fellow,
Indian Pugwash Society, New Delhi

The staff and students of Parthivi College Engineering and Management (PCEM) would like to subscribe to the Akshay Urja newsletter. We feel it will be an asset to our library.

Principal,
PCEM, Sirsakala, Bhilai

I am very impressed after reading the Akshay Urja newsletter. I would like to get it regularly and would like to know about the formalities to subscribe to it.

Aravind N Mahale,
Kanara Electrical Traders,
Honnavar, Kanataka

एमएनआरई, भारत सरकार द्वारा अक्षय ऊर्जा पर आधारित तथा आप द्वारा प्रकाशित मैगजीन बहुत अच्छी लगी। समय–समय पर वैकल्पिक ऊर्जा स्रोतो के बारे में नवीन जानकारी प्राप्त होती है तथा जनता में इस मैगजीन द्वारा यह संदेश जाता है कि आधिक से अधिक नवीन ऊर्जा का प्रयोग किया जाय तथा पारंपरिक ऊर्जा को संरक्षित किया जाय जिससे पारंपारिक ऊर्जा का उपयोग अधिक दिनों तक हो सके। मैं भी आपके पत्रिका से यह सन्देश देना चाहता हूँ कि भारत की जनता अधिक से अधिक नवीन एव्म नवीकरणीय ऊर्जा का प्रयोग करें तथा सरकार के प्रयत्न में सहयोग दे। तथा घरेलू उपयोग के साथ–साथ इसका व्यापारिक उपयोग सभी प्रतिष्ठानों में किया जाय नर्सिगं होम, होटल, गेस्ट हाऊस, फैक्ट्री, राइस मिल्स, कोल्ड स्टोरेज आदि में नवीकरणीय ऊर्जा का अधिक प्रयोग किया जाना चाहिए। आपसे अनुरोध है कि उक्त पत्रिका मेरे पते पर भिजवानें का कष्ट करें।

एस एम ए जिनी,
इलाहाबाद, उत्तर प्रदेश

अरविन्द महिला विकास क्लब समिति महिलाओं पर आधारित हैं तथा ग्रामीण क्षेत्र में कार्य कर रही है। आने वाला समय सौर ऊर्जा का है। कृपया संस्था को *अक्षय ऊर्जा* के नए अंक के साथ कुछ पुराने अंक भी भेजा जाए। कार्यालय के लिए 2011 का कैलेन्डर भेजने की कृपा करें।

श्रीमती अंजनी रस्तोगी, अध्यक्ष,
अरविन्द महिला विकास क्लब समिति,
मंहई चौक, बुदौन, उत्तर प्रदेश

Dear Reader, Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation. **Editor: Akshay Urja**

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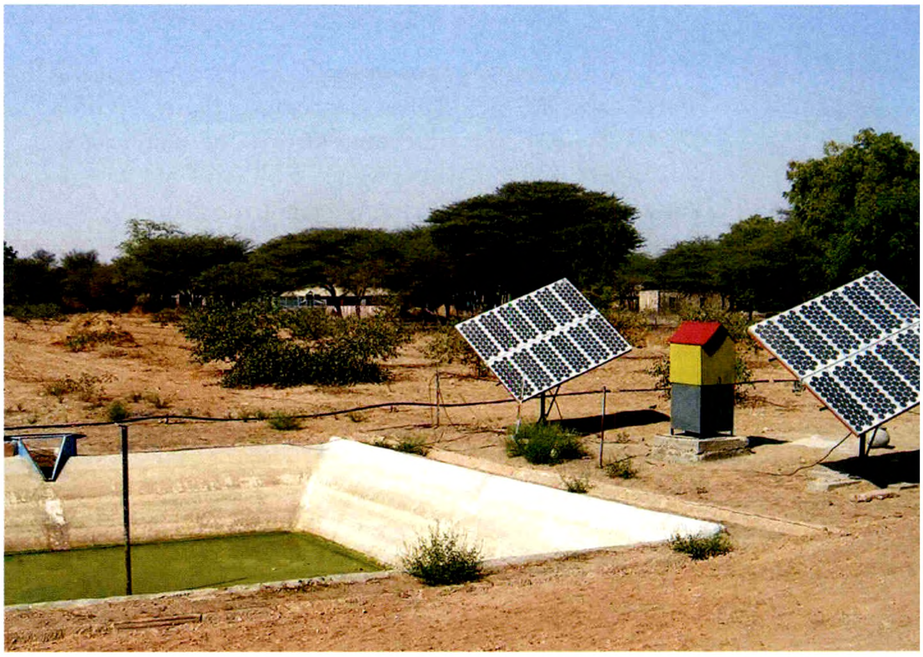

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Off grid and decentralised renewable energy applications are appropriate for a vast country like India.

The Ministry may look at addressing the gap in solar tariff in the next round of bidding.

The JNNSM in its first two phases will promote solar heating systems, which are already using proven technology.

500 MW Solar Park Opens in Gujarat

Asia's first solar power park which will generate 500 MW of solar power was inaugurated by Gujarat Chief Minister Shri Narendra Modi on 30 December 2010. Total cost amounts to Rs 10,000 crore shared among different entities. Phase I worth Rs 1287 crore is being developed by Gujarat Power Corporation Limited (GPCL) in Patan District. The World Bank has invested 1 billion USD for the project while the Planning Commission and the Asian Development Bank (ADB) have pledged substantial contributions. Once functioning, the Solar Park will generate 5,000 direct jobs locally.

Business Line, 31 December 2010

HCC Enters Renewable Energy Sector

Hindustan Construction Company (HCC), the leading engineering construction company has signed a memorandum of understanding (MoU) with the Government of Gujarat for setting up a renewable energy park in Ahmedabad District's proposed Dholera waterfront. The estimated investment is Rs 12,000 crore covering 600 acres of land and would create around 17,000 jobs. The park will offer a platform for global leaders looking to set up research, development, consultancy and manufacturing of components businesses in India in the renewable energy segments such as solar, geo-thermal, wind and biomass.

Indiaclimateportal.org, 12 January 2011

Solar Power Project Licenses up for Sale

Several companies that secured solar power projects from the government are selling the licenses at a premium to bigger firms. 80 such projects were allotted ranging from 100 kW to 2 MW in 2010. There is no bar on transferring licenses under the scheme. The incentives for the big firms paying premium include assured sales, revenues from carbon credits, tax holidays and availing of accelerated depreciation on equipment.

The Economic Times, 3 January 2011

Tata Power to Sell Solar Power to GUVNL

Tata Power signed an agreement on 22 December 2010, to sell power generated at its 25 MW solar photovoltaic project at Mithapur to Gujarat Urja Vikas Nigam Ltd (GUVNL). The plant spread across 100 acres of land along the coast line of Gujarat will be among the largest plants of its kind in the country and will be commissioned by December 2011.

The Financial Express, 23 December 2010

Reliance Power Plans to Augment Renewable Energy Production Capacity

Reliance Power plans to augment its renewable energy production to 1000 MW in 2-3 years. It has wind power generation projects in Karnataka, Tamil Nadu, Gujarat and Maharashtra - 9 MW, 18 MW, 19 MW and 48 MW respectively. Further plans are to set up a concentrated solar power plant (CSP) and a solar photovoltaic plant in Rajasthan to generate 600 MW and wind power plants in Gujarat and Karnataka to generate 400MW. NTPC is partnering Reliance Power in the solar thermal project while US based Export Import Bank is providing financial support to technology for these projects.

doing-it-green.com, 12 January 2011

BST Bags Rs 300 crore Project

BS Transcomm Ltd, a Hyderabad based solutions provider to power and telecom companies bagged a Rs 300 crore project from Rural Electrification Corporation Limited (REC) on 22 December 2010. This transmission system project is for the construction of the synchronous interconnection between the southern and western regions spanning 210 kms from Raichur to Sholapur and operation and maintenance for 35 years. The project which won a tariff based global competitive bidding will be completed by March 2014.

The Asian Age, 23 December 2010

Lanco Infra to Develop Solar Power in Rajasthan

Infrastructure and power company Lanco Infrastructure has got approval to develop a 5 MW photovoltaic (PV) project and a 100 MW solar thermal project in Rajasthan. This follows its commissioning of a 5 MW project in Gujarat where it is developing an overall capacity of 35 MW. In Rajasthan, Lanco has a target of producing 200-300 MW of solar energy in the next two years. The company has got a letter of intent (LoI) from NTPC Vidyut Vyapar Nigam, the government's designated agency for procuring solar power under the Jawaharlal Nehru National Solar Mission (JNNSM). The JNNSM has a target of producing 20,000 MW solar power by 2022. Lanco also offers engineering, procurement and construction (EPC) services to other solar power developers.

The Hindu, 21 December 2010

Powergear Foray into Renewable Energy

High voltage electricity equipment manufacturer Powergear Ltd has proposed a greenfield project with a European partner for entering the renewable energy sector. The Bangalore based company has been manufacturing bus ducts and control cubicles for the energy sector. The deal will be a Rs 150 crore project where the partner would provide technology and funding support, while Powergear will look after construction and operations.

Business Standard, 31 December 2010

BHEL in tandem with JNNSM

Public sector giant BHEL has been sanctioned three orders for setting up 2 MW solar photovoltaic power plants. The orders have been placed by Citra Real Estate and Sepset Constructions Ltd for their sites in Katol and Nagpur, Maharashtra and from Priapus Infrastructure Ltd for its site at Bareilly, Uttar Pradesh. The plants will be operationalised as per the Indian Renewable Energy Development Agency Ltd under Jawaharlal Nehru National Solar Mission (JNNSM).

Indian Express, 23 December 2010

MCD Schools to use Solar Power

In an effort to save on electricity bills, the Municipal Corporation of Delhi (MCD) has decided to use solar energy in its schools for the upcoming academic session. Provisions have been made in the budget for the next financial year to install solar panels in MCD schools. The project will cost Rs 5 crore out of which Rs 30 lakhs will be contributed by the World Bank. Electricity bills per year will reduce substantially while also minimising pollution. 10 lakh children studying in MCD schools will also gain awareness on environmental issues.

The Statesman, 3 January 2011

India Shale Gas Auction

A first shale gas auction in India will be launched by the end of 2011. The Directorate General of Hydrocarbons (DGH), India's upstream regulator, is fleshing out a new shale gas policy and identifying blocks for auction, which will be completed by April 2011. Analysts say the government needs to streamline its tax and royalty regimes if the new shale licensing round is to lure heavy investment. The government has hinted that the US will help India to prepare the necessary regulatory framework. India joined the US sponsored Shale Gas Initiative in November 2010.

Indianoilandgas.com, 10 January 2011

Maharashtra Seamless Enters into PPA with NTPC

Maharashtra Seamless Ltd announced entering into a power purchase agreement (PPA) with NTPC Vidyut Vyapar Nigam Ltd (NVVN). It is for a period of 25 years for selling electricity generated by the 5 MW capacity Solar Photovoltaic Power Project to be set up by the company in the state of Rajasthan. Maharashtra Seamless has been selected by NVVN to set up this photovoltaic power project under the Jawaharlal Nehru National Solar Mission of the Government of India.

RTT News, 13 January 2011

Repower to supply 48 Wind Turbines to Belgium

Repower Systems, a unit of wind turbine maker Suzlon Energy, has signed a contract with Belgium's C-Power for supply of 48 wind energy turbines. The turbines with capacity of 295 MW are part of phases 2 and 3 of Belgium's offshore wind farm- Thornton Bank. 24 turbines are slated for installation in phase 2 in 2012 and a further 24 turbines will be installed in 2013 as part of phase 3. Companies from Belgium, Germany, the Netherlands, France and Denmark are also involved in the project.

The Economic Times, 27 November 2010

Moser Baer Solar Farm in TN

Moser Baer Clean Energy has commissioned a 5 MW solar farm at Sivaganga, Tamil Nadu. Moser Baer Solar has provided technical expertise while the International Finance Corporation and the IDBI have contributed to project finance. The Tamil Nadu Energy Development Agency (TEDA) awarded solar farm will be connected to a 110 kVA local grid and will use amorphous silicon thin film technology, best suited to Indian conditions.

The Hindu, 21 December 2010

Solar Powered Wheelchair Sets World Record

Haidar Taleb, a 47 year old man from UAE, displayed a rare combination of human spirit and willpower when he took up a 200 mile long journey on a wheelchair that he has built for himself which runs on solar power. Afflicted with polio since the age of 4, Taleb was not discouraged from taking up this challenge on the customised solar powered wheelchair, a piece of technological innovation.

www.alternative-energy-news.info, 25 January 2011

China Rules Controlling Wind Power

Gamesa, the world's third largest wind turbine maker entered the business in 1994 and by 2005, held 35 per cent of the market in China. But in July 2005 China passed a new rule whereby wind farms' equipment purchases had to include a 70 per cent domestic manufactured content. This new directive was a violation of the World Trade Organisation (WTO)'s rules. In this way, local manufacturers acquired foreign technology and today Chinese companies control half the world market and 85 per cent local market aided by low interest loans and cheap land from government. Gamesa's share has reduced to a trickle but its overall revenues have doubled.

The Asian Age, 28 December 2011

Solar Plane is Record Breaker

The UK built solar powered plane Zephyr, has achieved an unprecedented feat of flying non stop for two weeks. This plane can track pirates, alert authorities about spread of forest fires and ensure soldier communications. It remains unaffected when fighting in hilly terrain. It beat a record set in 2001 by Northrop Grumman's Global Hawk by a factor of 11.

The Asian Age, 26 December 2011

Suzlon Energy to build 150 MW wind power projects in India

Suzlon Energy, India's largest wind turbine manufacturer has signed an agreement with Hindustan Zinc Ltd, to build and operate 150 MW of wind power projects in Karnataka, Maharashtra, Rajasthan and Tamil Nadu. The total value of the deal is worth 91 million USD including orders for Suzlon's S82-1.5MW and S88-2.1MW wind turbine models. The projects will be completed in two phases, the first 50 MW being put into operation by March 2011, and the remaining 100 MW coming on line in September 2011. Power generated by the facilities will be purchased by the respective state's distribution utilities at the prevailing feed-in-tariff under a long term power purchase agreement.

powergenworldwinde.com, 7 January 2011

Gamesa set to invest Rs 1500 crore in 3 Units

World's third largest wind turbine manufacturer Gamesa has proposed three different plants - wind blades, nacelles and wind turbine towers in India. It will also make inverters for the large solar PV industry in the nation at its upcoming facility in Chennai worth Rs 1500 crore. The initial capacity of these wind turbines will be 200 MW to be scaled up to 1000 MW in two years. The total cost for the project is expected to be 70 million Euro of which 11 million Euro has been raised from the International Finance Corporation (IFC). The wind turbines will be specifically for Indian conditions.

The Financial Express, 25 December 2010

Positive Vibes in RE

A survey published by the European Commission shows that Europeans are extremely positive about solar and wind energy. Only 4 per cent of the respondents had negative views on these energy resources while 84 per cent and 87 per cent respondents gave positive feedback on wind and solar energy, respectively. Nuclear power did not garner such high positive reactions.

Balkans Business News, 10 January 2011

World's Most Powerful Wind Turbine in Germany

Enercon has announced installation in Magdeburg, Germany of the first wind turbine of type E-126 with a capacity of 7.5 MW. It is thus the world's most powerful wind turbine. Its hub height is 135 m and it will yield electricity to supply 6,000 households.

The Financial Express, 27 December 2011

African Island to Meet 25 per cent Needs from Renewables

The African island nation of Cape Verde is set to meet a quarter of its energy requirement through renewable sources. By 2012, a 28 MW Cabeolica wind facility would be operational. The European Investment Bank has provided a loan of 45 million Euro to meet the initial investment needs.

Financial Express, 27 December 2010

Los Angeles Meets Renewable Energy Goal

Los Angeles has met its goal of providing 20 per cent of the city's power from renewable sources in 2010 largely due to a wind plant. Mayor Antonio Villaraigosa set the energy goal, which was achieved by opening the municipally owned Pine Tree Wind Power Plant in the Tehachapi Mountains.

The Associated Press, 14 January 2011

Forecasting Wind Data with Cell Phone Towers

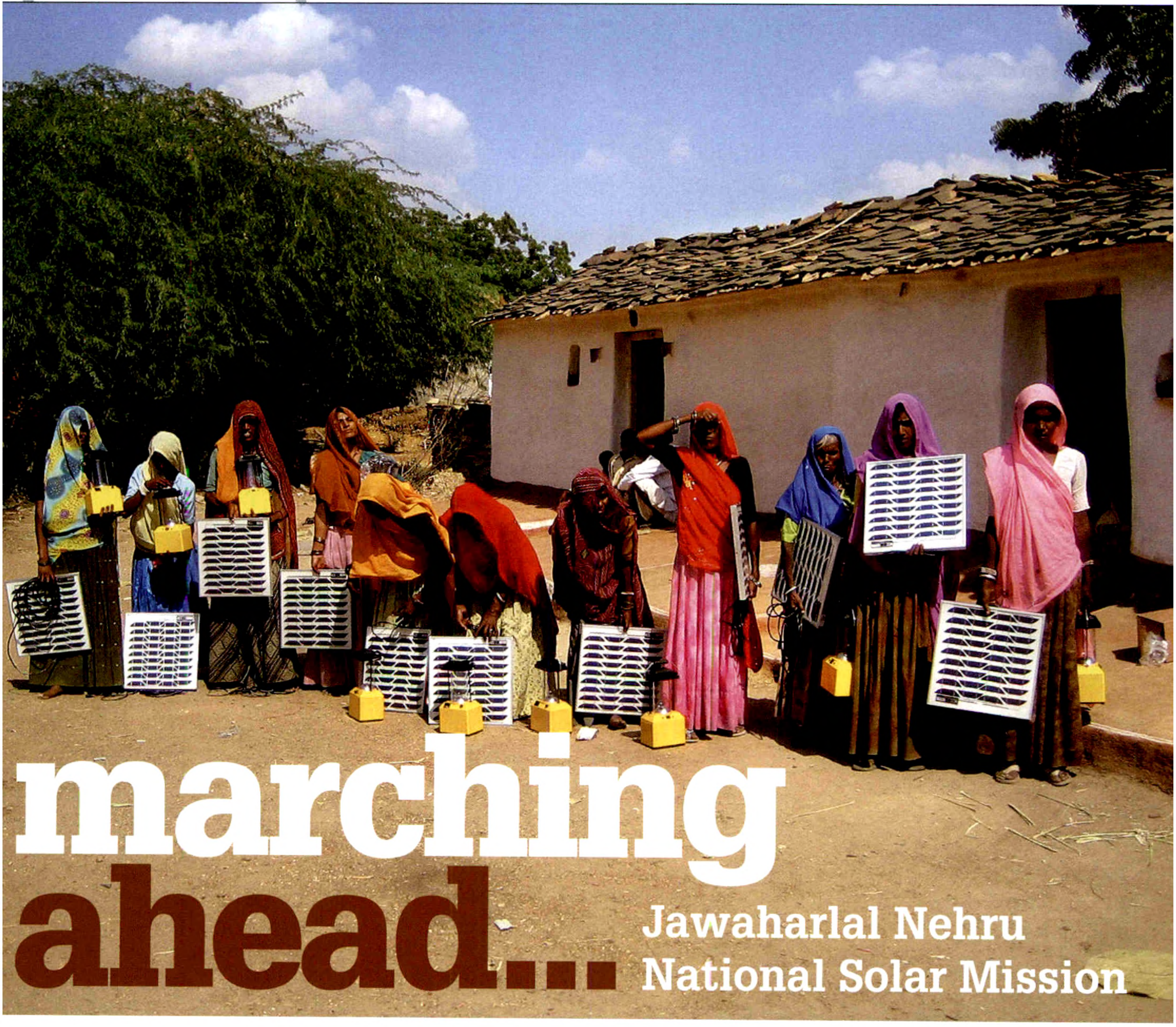
Wind data provider Onesemble has developed sensors which can keep note of wind data for around 95 per cent of the wind farms existing in the Texas area. The help of cell phone towers is sought for this purpose. Onesemble Network Sensors collect accurate data by getting to know the wind speed at a great height. This is done by placing the sensor at the height of the turbine rotor or the blades. Onesemble Network Sensors assemble figures on wind speed, direction and temperature in a cell phone tower, which are then analysed on a computer to point out what is going to happen in times to come. Data is supplied through a network of 100 sensor centres. Forecasting can be enabled every 10 minutes with the help of real time data from the sensors fed into its system. The data fed and the predictions that are attained this way are both quite precise.

alternate-energy-news.info, 30 November 2010

World's Fastest Solar Car

Australian students have designed a solar car which travels at speeds of 88 kmph, thus breaking the Guinness World Record for solar car speed previously set at 79 kmph. The Sunswift Ivy uses cells to charge a 25 kg battery and produces about 1200 watts of power. Clear sunshine is enough to run the car at record speeds.

The Times of India, 13 January 2011



marching ahead...

Jawaharlal Nehru National Solar Mission

On 11 January 2010 India launched the Jawaharlal Nehru National Solar Mission (JNNSM), for development and deployment of solar energy technologies in the country. The immediate aim of the Solar Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralised and decentralised level.

By **Staff Reporter**

India is a party to the United Nations Framework Convention on Climate Change (UNFCCC), which sets an overall framework for intergovernmental efforts to tackle challenges posed by climate change. India has reasons to be concerned about the impact of climate change since a large part of its population depends on climate sensitive sectors like agriculture and forestry for their livelihood. Any adverse impact on water availability would threaten food security and also affect the achievement of vital national developmental goals.

Planning in India seeks to increase wealth and human welfare, while simultaneously conserving the environment.

Emphasising on this aspect, the Prime Minister, Dr Manmohan Singh said, "I believe that ecologically sustainable development need not be in contradiction to achieving our growth objectives."

A range of policies and programmes have been initiated to address the problem of climate change in the context of sustainable development - promoting renewable energy is one of them. India is witnessing rapid economic growth and consequently resource demand has increased manifold, particularly for energy.

The Solar Mission and Climate Change

In the build up to the 2009 Copenhagen conference, the Bali Action Plan (BAP) was adopted in the UNFCCC in December 2007. One of the main pillars of the BAP was the Nationally Appropriate Migration Actions (NAMAs) - which are voluntary actions to be taken up by developing countries for reduction in green house gases (GHGs) and towards mitigation of climate change, according to their individual national circumstances, capabilities and resources. In India the NAMAs laid the foundation for the formulation of the National Action Plan for Climate Change (NAPCC), which was released by the Prime Minister, Dr Manmohan Singh on 30 June 2008. The NAPCC outlines a national strategy that aims to enable the country to adapt to climate change and enhance the ecological sustainability of India's development path.

Eight national missions form the core of the NAPCC, representing multi-pronged, long term and integrated strategies for achieving key goals in the context of climate change. These missions are: National Solar Mission; National Mission on Enhanced Energy Efficiency; National Mission on Sustainable Habitat; National Water Mission; National Mission for Sustaining the Himalayan Ecosystem; National Mission for a Green India; National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change.

Consequent to the announcement of the NAPCC, the Ministry of New and Renewable Energy (MNRE), Government of India, on 11 January 2010 launched the Jawaharlal Nehru National Solar Mission (JNNSM), for development and deployment of solar energy technologies in the country to achieve parity with grid power tariff by 2022.

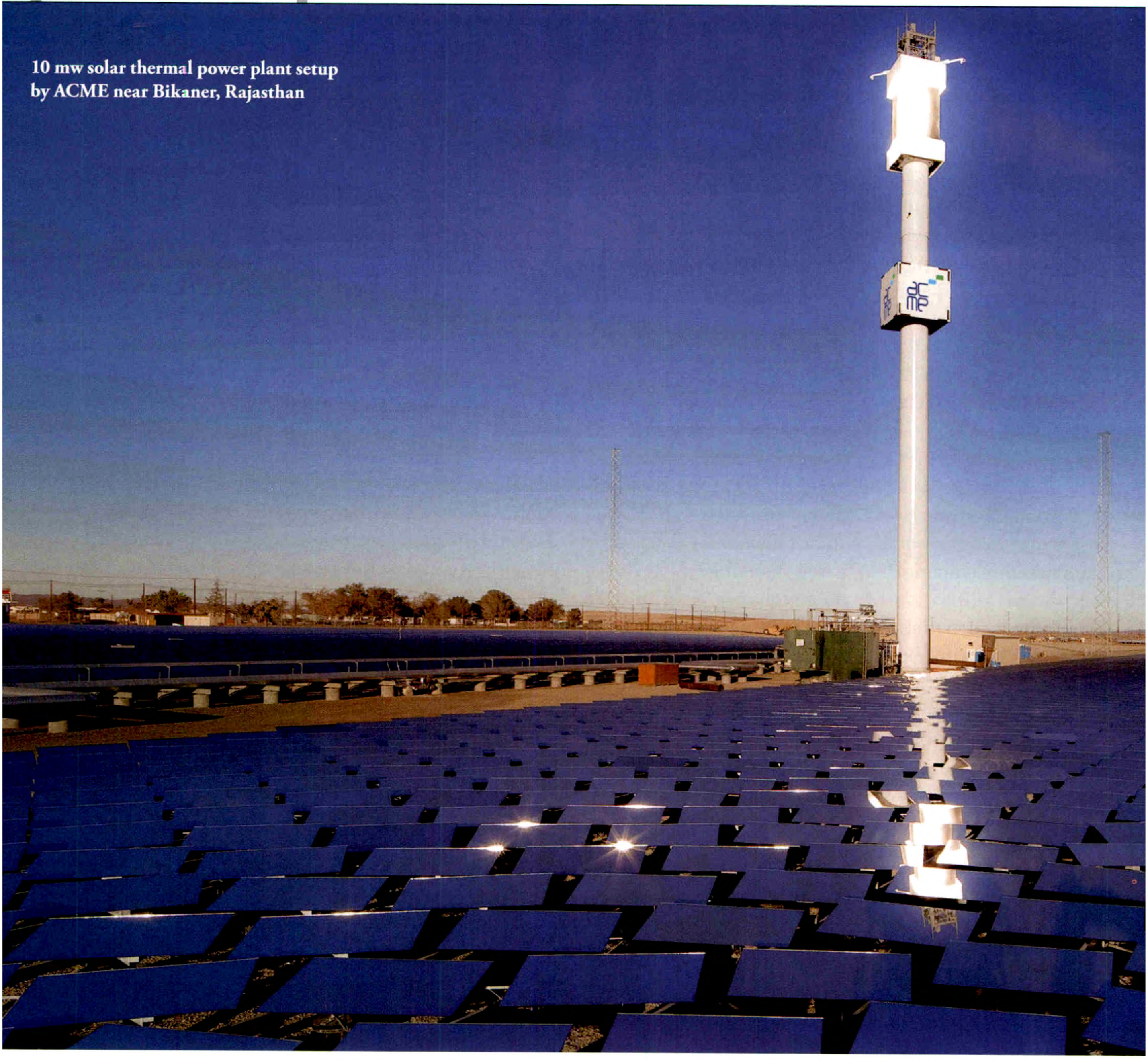
The Solar Mission and Energy Security

The Integrated Energy Policy 2006 emphasises on ensuring energy security. It broadly aims at establishing the continuous availability of commercial energy at competitive prices to support economic growth and meet the energy needs of households with safe, clean and convenient forms of energy. The policy recognises the importance of renewable energy from a long term perspective keeping in mind the need to maximally develop domestic supply options as well as the need to diversify energy sources. NAPCC reinstates the importance of renewable energy, especially solar energy as it points out: "India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as a future energy source. It also has the advantage of permitting decentralised distribution of energy, thereby empowering people at the grass root level". Based on this vision the JNNSM was launched.

> **"I believe that ecologically sustainable development need not be in contradiction to achieving our growth objectives."**
> **-Dr Manmohan Singh.**

Beneficiary of solar a lantern

COUTESY: BAL RASHMI SOCIETY-JAIPUR



10 mw solar thermal power plant setup by ACME near Bikaner, Rajasthan

Timeline

The JNNSM adopts a three phase approach. Spanning the remaining period of the 11th Plan and the first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3.

Objectives and Proposed Roadmap

The objective of the JNNSM is to establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible.

The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralised and a decentralised level. Phase 1 will focus on capturing the low hanging options in solar thermal and promoting off grid systems to serve populations without access to commercial energy and a modest capacity addition in grid based systems. The greatest potential area of off grid relates to solar technologies. These include solar water heating systems, home lighting systems comprising of solar lanterns, solar cooking systems, solar pumps and small power generating systems. Under the Solar Mission, it has been proposed to cover 2000 MW equivalent by 2022 which includes all of the above, except solar water heating systems for which there is a separate target of 20 million sq m. Within the off grid component, there is a separate target of covering 20 million rural households with solar lights. This includes coverage under the Remote Village Electrification Programme (RVEP) wherein solar lighting is provided largely to off grid villages and is almost entirely funded by central grants. In addition, in other areas, where grid is available but power supply is erratic, solar lighting is financed through loans given by rural banks.

In Phase 2, after taking into account the experience of the initial years, capacity will be aggressively ramped up to create conditions for upscaled and competitive solar energy penetration in the country. The proposed road map for attainment entails large scale deployment of grid connected as well as distributed solar generated power, and also decentralised off grid provision for commercial energy services. The deployment across the application segments as envisaged is given in Table 1.

> **Phase 1 will focus on capturing the low hanging options in solar thermal; on promoting off grid systems to serve populations without access to commercial energy and modest capacity addition in grid based systems.**

Phase 1 target (up to March 2013)

- Government has approved the implementation of Phase 1 of the Mission and the target is to set up 1000 MW grid connected (33 KV and above) solar power plants through NTPC Vidyut Vyapar Nigam (NVVN), a trading subsidiary of National Thermal Power Corporation (NTPC) Limited. NVVN will directly purchase the solar power from the project developers as per the norms and guidelines fixed in this regard.
- The Mission will encourage 100 MW rooftop solar photovoltaic (PV) and other small solar power plants, connected to LT/11 KV grid, to replace conventional power and diesel based generators. It is envisaged that the distribution utility will pay the tariff determined by the State Electricity Regulatory Commission (SERC) for the metered electricity generated from such applications (whether consumed by grid connected owner of the rooftop/ground mounted installation or fed into the grid).
- Deployment of 200 MW capacity equivalent off grid solar applications of solar thermal technologies (e.g. solar water heaters, solar cooking systems, air drying, steam cooking and power generation, sterling engine etc.) and PV technologies (e.g. solar PV home lighting, police station communication and lighting, tribal habitats, small powered looms, solar inverters, solar PV pumps, powering computers in schools, small milk chilling plants, refrigeration for medicines in primary health centres; systems for powering telecom towers, etc.). In addition hybrid systems would also be supported and will be implemented through a combination of low interest loans and/or central financial assistance as per norms and guidelines fixed in this regard.
- Acquiring 7 million sq m of solar thermal collector area.
- Supporting various activities as necessary in research and development, human resource development, technical assistance, training, publicity and awareness etc., for successful implementation of the Mission.

The Solar Mission's strategy in Phase 1 and 2 includes

Solar home lighting systems

Table 1: Deployment across application segments

Application Segment	Target for Phase 1 (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
Solar collectors	7 million sq m	15 million sq m	20 million sq m
Off grid solar applications	200 MW	1000 MW	2000 MW
Utility grid power, including roof top	1100 MW	4000-10000 MW	20000 MW

A telecom tower running on solar power

COURTESY: DELTA

the announcement of the broad policy framework to achieve its objectives by 2022. The Mission document states that the policy will create the necessary environment to attract industry and project developers to invest in research, domestic manufacturing and development of solar power generation and thus try to create a critical mass for the domestic solar industry. The Mission will work closely with the state governments, regulators, power utilities and local self government bodies to ensure that the activities and policy framework being laid out can be implemented effectively.

Progress so far

(I) Grid connected solar power projects

During 2010-11 the Ministry has selected grid solar power projects of 800 MW capacity for implementation and power purchase agreements (PPAs) have been signed with investors. Grid connected solar power generation is a new application in the country and so far a limited capacity has been set up. Therefore, the annual targets and the requirement of funds have been set only to gradually achieve 1100 MW capacity by March 2013. In Phase 1, this comprises of the following main components:

1000 MW capacity grid solar power plants

- 84 MW capacity, connected to 33 KV and above, grid connected solar power projects have been allocated by the NVVN under the migration scheme. NVVN has signed power sale agreements (PSAs) and PPAs with the concerned states and project developers in October 2010.
- NVVN had issued request for selection (RfS) of projects of 620 MW capacity (470 MW of solar thermal and 150 MW of PV) in August 2010.
- NVVN received 423 applications for a total of 441 projects. 363 proposals were to set up PV plants of 1815 MW (at an average of 5 MW per applicant). 78 applications were for 3311 MW capacity of solar thermal projects. In October 2010 NVVN completed the scrutiny of applications for setting up the new grid connected solar power projects. NVVN then issued request for proposal (RfP) to the selected applicants, who were requested to submit their offer of discount on the Central Electricity Regulatory Commission (CERC) tariff by November 2010 for final selection of projects.

100 MW capacity solar power plants

- Projects to set up 100 MW capacity (connected to grid below 33 KV and of 100 kW to 2 MW size) have been short listed by Indian Renewable Energy Development Agency Ltd. (IREDA). All the project developers have already signed PPAs with the concerned state level utility.

Eight grid connected solar PV power projects of about 15 MW capacity have been installed in the country during the last one year. This is a satisfactory beginning considering that small capacity projects of only about 2.1 MW were installed before this.

(II) Off grid solar power projects

Approximately 33 MW capacity off grid solar power projects have been sanctioned as on 10 January 2011, against a target of 32 MW for 2010-11 (Table 2). The sanctioned systems include solar power plants, street lighting systems, home lighting systems and solar lanterns for installation at

Community power plant at Rampura

police stations, hospitals, bank branches, telecom towers, bus stations, educational institutions, para military forces and border villages with scheduled caste population etc. A budget of Rs 224 crore was earmarked for the programme in the year 2010-11. The entire allocated amount was spent by December 2010.

Home lighting systems

During March to December 2010 the Ministry has electrified 300 villages and sanctioned 341 projects for electrification. Households in about 7,000 remote villages and hamlets have so far been provided home lighting systems under this programme. The sanctioned systems include solar power plants, street lighting systems, home lighting systems and lanterns. One of the major initiatives among these is to provide solar PV systems of 10.28 MW capacity to all 9,168 Panchayat buildings in Rajasthan and 1.7 MW capacity solar PV power plants for tribal hostels, police stations and forest check posts in Madhya Pradesh.

Solar thermal water heaters

The Ministry under the Solar Mission has sanctioned support for solar thermal water heating systems to Haryana Renewable Energy Development Agency (HAREDA) and Non Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP). Recently, the Ministry has sanctioned capital subsidy for installations of solar thermal systems to some state government agencies including the AP Rajiv Swagruha Corporation in Andhra Pradesh and Shri Mata Vaishno Devi Shrine Board in Jammu and Kashmir. Subsidies are made available to the state agencies, which can be transferred to end users at the time of installation of the solar powered systems. At present a capacity of 60,000 sq m has already been sanctioned to the states and several state agencies are coming forward for installation of solar thermal systems.

Stand alone rural solar plants

Working towards its commitment to set up stand alone rural solar plants in the special category states and remote and difficult regions including border areas, the Ministry has sanctioned projects to set up power plants in Lakshadweep, Arunachal Pradesh, Jammu and Kashmir, Punjab (Gurdaspur), Sikkim, Uttarakhand etc., as on 7 January 2011.

(III) Financial assistance and soft loans

The Ministry is promoting lighting and hot water systems through the National Bank for Agriculture and Rural Development (NABARD) across the country. Under this

> **The Mission will work closely with the state governments, regulators, power utilities and local self government bodies to ensure that the activities and policy framework being laid out can be implemented effectively.**

Table 2. List of projects sanctioned under off grid solar applications of JNNSM as on 10 January 2011

State	Sanctioned systems	Location	Capacity (kW)
Andhra Pradesh	Power plants and street lights	Educational institutes, MPDO offices, commercial organisations, telecom towers, theatres, NGOs, homes, art galleries, engineering colleges and tribal villages	1681
Arunachal Pradesh	Power plants	SSB Battalian HQ and border outposts	320
Assam	Power plants	Guwahati University, SSB Assam Engineering College	500
Bihar	Power plants	Telecom towers and bank branches	1022
Chhattisgarh	Power plants	Rural bank branches, hospitals, temples, Government Institutes, PWD guest houses, SBI branches, Industry/ charitable organisations	2282
Gujarat	Power plants	Saurashtra University	25
Haryana	Power plants, solar PV street lighting systems	330 villages in Sirsa, TERI retreat Gwalpahari, BPDO offices in Sirsa and Hospital at Rewari, rural branches of Banks in 13 districts	832
Himachal Pradesh	Power plants, SPV street lights, home lights, solar lanterns	SSB training centres, 34 villages in 5 districts	529
Jammu and Kashmir	Power plants, home lights, solar lanterns	Leh District, Kargil District, 69 health centres, Vaishno Devi Shrine	2829
Jharkhand	Power plants	Temples in Deogarh, BIT Deogarh, Palamu Tiger Project, Jari village	416
Karnataka	Power plants	Bus stations, KDA, 50 branches of Vikas Gramin Bank, 10 other locations	195
Kerala	Power plants	Balklava Sweets, Thodupuzha	10
Lakshadweep	Solar power plants	Islands	1100
Madhya Pradesh	Power plants, SPV street lights	Tribal hostels, police stations, forest check posts, CHCs, 438 villages	1927
Maharashtra	Solar power plants	Thane Municipal Corporation and SEEPZ SEZ	150
Manipur	SPV solar plants	Hospitals, jail and State Training Academy	100
Meghalaya	Power plants, home lights	Schools and aganwadi centres	639
Mizoram	SPV power Plants	Charitable institutions, hospitals	121
Orissa	Power plant	Secretariat	50
Punjab	SPV power plants, power plants	Educational institutions, 17 villages in Gurdaspur	505
Rajasthan	Power plants, PV pumps, home lighting system	Gram Panchayats, horticulture department, villages in 20 districts	10907
Sikkim	Power plants	Border outposts of SSB	115
Tamil Nadu	Power plants	Schools, Vaishnavi College, commercial organisations	107
Uttarakhand	SPV street lighting systems, power plants, solar lanterns	316 villages, Battalion HQ and Border Posts of SSB, 9 international border blocks, 381 villages, BEL Kotdwaar	2109
Uttar Pradesh	Power plants, street lighting systems	2,964 villages, 57 Ashram schools, 294 bank branches, 70 Baroda UP Gramin bank branches, telecom towers	3568
Others	Power plants, street lights, home lights	Bank branches, educational institutions, villages	853
		Total	**32892 kW**

Source: MNRE

programme all regional rural banks will finance solar lighting for the users by providing capital subsidy of 30 per cent and soft loans at 5 per cent interest per annum, for which the Ministry is providing the funds. Details of promotional activities and incentives provided by the Ministry for the Solar Mission are:

- Capital subsidy for select devices and systems,
- Generation based incentives for power generation from wind and solar energy,
- Interest subsidy on select renewable energy devices and power projects,
- 80 per cent accelerated depreciation during first year,
- 10 year tax holiday for power projects,
- Nil or concessional customs duty,
- Excise duty exemption on specific devices and systems,
- 5 per cent duty on solar power projects,
- Loans through IREDA,
- Preferential tariff by some of the states on renewable power,
- Publicity and awareness campaigns through print and electronic media,
- Attainment of grid parity, discounting process for identifying investors has led to 30 per cent discounts on CERC tariff.

(IV) MNRE's promotional schemes

Promotion schemes for off grid applications:

- For Solar PV power packs a 30 per cent capital subsidy and loan at 5 per cent on 50 per cent of the capital cost has been put in place. MNRE considered Rs 300 per watt (with battery) as the benchmark for extending a 30 per cent capital subsidy, which amounts to Rs 90 per watt. It is Rs 70 per watt without battery. Also, PV crystalline silicon solar cells should be used.

Weaving at night with a solar lantern

One of the main objectives of the Solar Mission is to globally take a leading role in manufacturing of cutting edge solar technologies.

- For solar thermal heaters subsidy is provided at Rs 3,000 per sq m for evacuated tube collectors (ETCs) and Rs 3,300 per sq m for flat plate collectors (FPCs).
- In respect of home lighting systems of up to 200 W lighting with 2x100AH battery set, an estimated cost of Rs 60,000 was prescribed by MNRE. The subsidy on the same is Rs 18,000 and loan amount is Rs 30,000. Inverter based systems are also eligible for financing schemes.
- To meet electricity requirements of unelectrified rural areas, a capital subsidy of up to Rs 150 per watt will be extended for mini local grids.
- Individuals are eligible up to 1 kW (5 kW for water pumping schemes) capacity and commercial/non commercial entities are eligible up to 100 kW. Micro grids of up to 250 kW capacity can be set up.
- Capital subsidy would be released to the banks upfront, on receipt of sanction of loan by the bank to the borrower. The loan amount is repayable in monthly instalments within 5 years. The banks will get refinancing of loan amount from NABARD (through IREDA) at 2 per cent.

Schemes for promotion of grid interactive renewable energy power projects:

The Ministry has been providing subsidies to various organisations for grid interactive power generation projects based on renewable energy sources. For grid connected projects of at least 100 kW and up to 2 MW, connected to HT level (below 33 kV) of distribution network, a grid based incentive is payable to the project developer. Its value is the difference between the tariff determined by the CERC (Rs 17.9 for solar PV and Rs 15.4 for solar thermal) and the base rate, which is equal to INR 5.5 per kWh for the financial year of 2010 to 2011, and escalates 3 per cent every year. In addition to various schemes, the debt portion of investment can be financed by a soft loan at 5 per cent interest rate, which can be availed from IREDA.

Solar lantern making the nights bright

(V) Accessibility

To ensure access, MNRE is promoting the home lighting and hot water systems through NABARD. All regional rural banks will provide capital subsidy and soft loans to the users for which the funds will be provided by MNRE.

(VI) Research and development

The focussed efforts of the government on research and development include:

Solar PV technology

Government efforts to support research and development in PV technology are through (i) supporting research groups and industry in reducing the cost of solar cells, modules and systems by improving the conversion efficiency, reducing the consumption of raw materials and developing new materials and processes; (ii) developing more efficient and low energy consuming loads for use with PV systems; (iii) supporting industry to indigenously produce critical materials such as silicon etc.; (iv) improving the reliability and life of PV products and systems; and (v) encouraging volume production in the country by facilitating market development including exports etc. The Ministry has identified the thrust areas of research and nine projects on different aspects of solar PV technology are under implementation.

Solar thermal

Research and development activities in the area of solar thermal energy have led to significant achievements in the improvement and commercialisation of solar water heating systems and solar cookers. The technology of solar flat plate collectors used in solar water heating systems has changed from black painted absorbers to selectively coated absorbers;

the workmanship, finishing, piping and system design have also markedly improved. A number of models of solar cookers are now available commercially. These include box type model for domestic use, dish concentrating cookers for individuals and small establishments, community (Scheffler) solar cookers for indoor cooking, and steam cooking systems for large kitchens catering to the cooking requirements of thousands of people. Research activities have also been undertaken to establish the efficacy of various concepts of solar architecture.

Cutting edge research and development

Six major research and development projects, three each in solar thermal and PV technologies have been sanctioned. Projects with strong industry interface have been encouraged.

Centres of excellence

National Centre for Photovoltaic Research and Education (NCPRE) has been set up at the Indian Institute of Technology (IIT), Mumbai. While the Amrita Centre for Nanosciences and Molecular Medicine (ACNSMM) at Cochin and the Centre for Solar Passive and Green Building at Center for Environmental Planning and Technology University (CEPT), Ahmedabad are being set up.

Supporting start ups and innovations

The Centre for Innovation Incubation and Entrepreneurship (CIIE) has been set up in collaboration with the Indian Institute of Management (IIM), Ahmedabad to promote innovation in renewable energy and to provide incubation, mentoring and financial support for aspiring entrepreneurs and innovators.

Solar Energy Centre

The Ministry has set up a Solar Energy Centre at Gwalpahari, Gurgaon. The Centre has world class facilities for testing solar thermal and solar PV devices and systems. In addition the Centre is also providing training and consultancy support to various user organisations. As a result of the efforts made by the Centre the Indian solar energy industry is able to meet various national and international standards for solar energy systems. In addition the Centre is also undertaking joint research on (i) testing and field performance evaluation of solar cells, modules and systems, (ii) development of secondary reference solar cells, (iii) development of long life batteries for solar PV systems, and (iv) development of new applications.

(VII) Developing human resources

Training

Model course content to teach solar energy at B.Tech, M.Tech and ITI levels has been prepared. Some of the National Institutes of Technology (NITs) have started following this course. In collaboration with Director General of Employment and Training, Ministry of Labour, course material for craftsmen training and modular skill development has been finalised.

Power station at Kurawa Village, Jharkhand

> **To achieve the local demand, right levels of incentives for solar generation have to be continued, with a combination of financing.**

Technicians programme

An MoU has been signed with Indira Gandhi National Open University (IGNOU) to start a technicians programme in the areas of solar PV and solar thermal from the next academic year. Course content to provide such specialised training to ITI passed technicians on PV, solar thermal energy and solar thermal power systems has been developed.

National Solar Fellow

This scheme has been developed to encourage innovative ideas in research and development and to promote research and product development in the area of solar energy.

Other human resource development (HRD) schemes

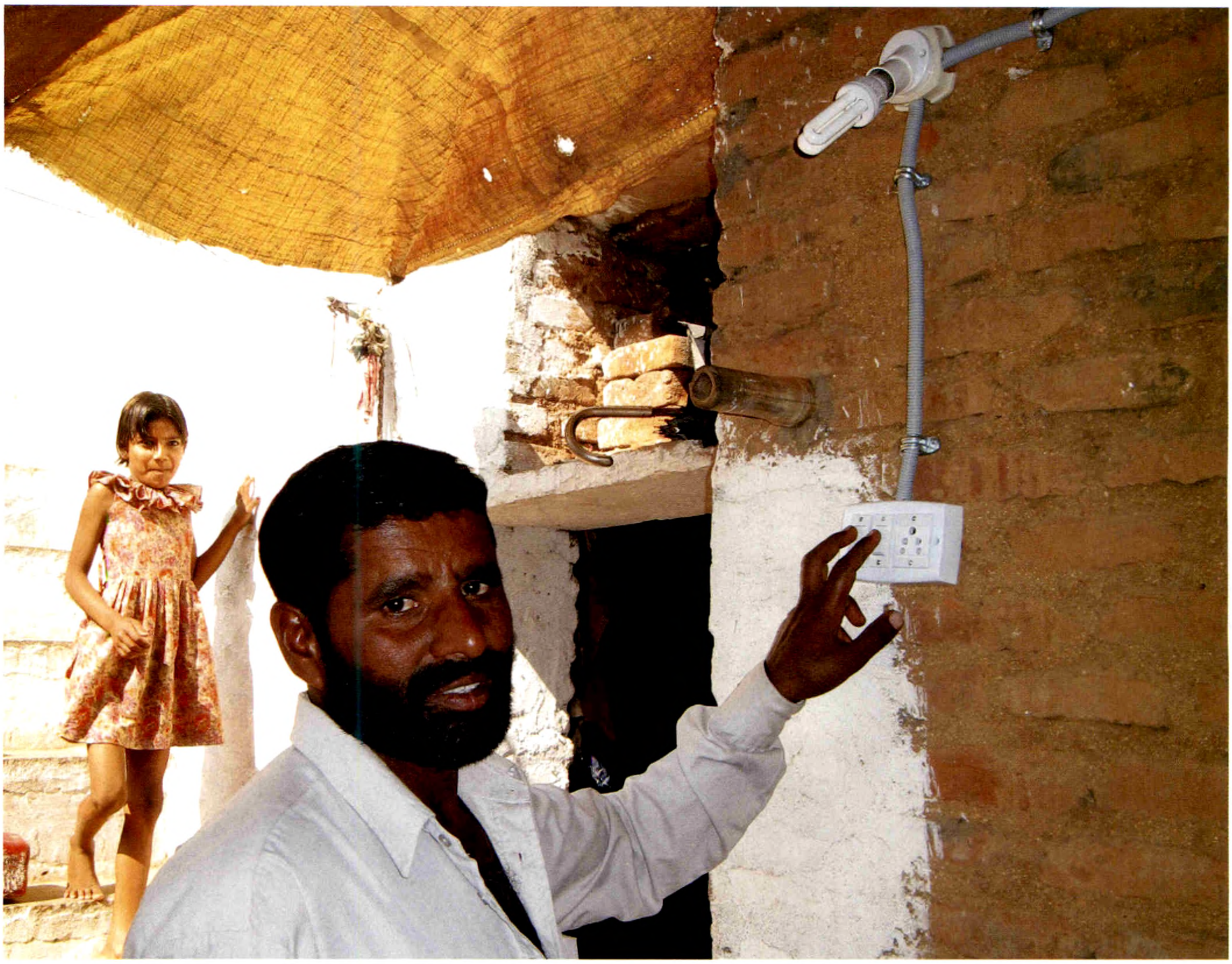
The Ministry has expanded the HRD scheme to (i) award substantially higher number of fellowships for pursuing postgraduate and doctoral programmes in the area of renewable energy (RE); (ii) provide grant for up gradation of laboratory facilities; (iii) provide support for RE chairs etc.

Way ahead

One of the main objectives of the Solar Mission is to globally take a leading role in manufacturing (across the value chain) of cutting edge solar technologies and target a 4

Table 3: List of selected projects by NTPC Vidyut Vyapar Nigam Limited (NVVN)

State	Location	Project capacity (MW)	Solar project type
Andhra Pradesh	Kutagulla, Kadiri, Anantapur	5	PV
	T Veerapuram, Ravadurg, Anantapur	5	PV
	Thummala, Amadgur, Anantapur	5	PV
	Virannapalle, Pamidi, Anantapur	50	Thermal
Gujarat	Dwarka, Mojap, Jamnagar	20	Thermal
Karnataka	Murudi, Molakalmur, Chitradurga	5	PV
	Mandva, Malavalli, Belakavadi	5	PV
Maharashtra	Kalhe	5	PV
Orissa	Khurda	5	PV
Rajasthan	Mundwa, Naguar, Naguar	5	PV
	Bhojas, Khinvsar, Nagaur	5x6 = 30	PV
	Kathali, Javal, Nagaur	5	PV
	Kantia, Nagaur	5	PV
	Bap, Phalodi, Jodhpur	5x2 =10	PV
	Amla, Phalodi, Jodhpur	5	PV
	Rawre, Phalodi, Jodhpur	5	PV
	Natisara, Phalodi, Jodhpur	5	PV
	Deh, Kolayat, Bikaner	5	PV
	Gajner, Kolayat, Bikaner	5	PV
	Ladkan, Kolayat, Bikaner	5	PV
	Marudi, Barmer	5	PV
	Pareware, Jaisalmer	5	PV
	Lanwa, Pokran, Jaisalmer	5	PV
	Nokh, Pokhran, Jaisalmer	5	PV
	Chinnu, Nachna 1, Jaisalmer	100	Thermal
	Chinnu, Nachna, Jaisalmer	100	Thermal
	Pokaran, Pokaran, Jaisalmer	100	Thermal
	Parewar, Jaisalmer	50	Thermal
	Nokh, Pokhran, Jaisalmer	50	Thermal
Tamil Nadu	Kombukaranatham, Tuticorin	5	PV
Uttar Pradesh	Naini, Allahabad	5	PV
	Total	**620 MW**	



Solar home lighting in Jhansi District, Uttar Pradesh

to 5 GW equivalent of installed capacity by 2020, including setting up of manufacturing capacities for polysilicon material to make about 2 GW capacity of solar cells annually. It is necessary to augment the indigenous capacity to manufacture silicon material by setting up more plants in the public and private sector. New facilities are being created to manufacture concentrators, collectors, receivers and other components to meet the demand for solar thermal plants. To achieve the local demand, right levels of incentives for solar generation have to be continued with a combination of financing to set up solar farms. Transparent and fast track clearances and permissions are being created in consultation with the states. The creation of land banks for solar farms has also been explored. To attain grid parity initial attractive tariff and a reduction in capital cost is necessary. The efforts from the Ministry are in the right direction to reduce the generation cost of electricity in the next 8 to 10 years through concerted research and development. In the coming 2 to 3 years the on going research efforts are expected to improve the conversion efficiency of solar cells from the existing 15-16 per cent to about 18 per cent. Further, efforts are being made by the industry to reduce the consumption of the main raw material - silicon wafers. These measures are expected to reduce the cost of crystalline silicon solar cells and modules by about 15 per cent, from the present average price of Rs 120 to Rs 100 per watt. The Ministry is already working on the following future directions:

- 50 new solar radiation monitoring stations - These new monitoring stations are being set up to provide reliable ground data for setting up solar projects.
- Doubling of solar cells capacity - Capacity of solar cells production has doubled from about 600 to 1300 MW.
- 4 test laboratories set up - These laboratories have been set up for PV module qualification testing.
- 300 MW capacity PV projects - The remaining 300 MW PV will be selected in 2011-12 for implementation.

International Renewable Energy Expo and Conference - Chennai

VaVoVa 2011, an international conference cum exhibition on renewable energy was organised in Chennai from 14 - 16 of January. A workshop was organised by Tamil Nadu Energy Development Agency as a parallel event to the VaVoVa 2011.

By **Shubhra Kingdang**

A three day solar energy conference was jointly organised by the Tamil Nadu Energy Development Agency (TEDA) and Tra International Ltd. at the Mamallapuram Beach Resort and the Chennai Trade Centre, Nandampakkam, in Chennai, Tamil Nadu on 14, 15 and 16 of January 2011. The workshop was organised as a parallel event to the VaVoVa 2011, an international conference cum exhibition on renewable energy. Tamil Nadu was the first to install wind energy generators (WEG) and TEDA was the first nodal agency to be established in India for the purpose. The Ministry of New and Renewable Energy (MNRE), India has announced an ambitious four fold increase in renewable energy by 2022 to a capacity of 72.4 GW and Tamil Nadu aims to continue being in the leadership in this growth. Twenty four sessions were held in the three days and numerous topics were discussed including; Renewable Energy Certificates (REC), REC trading, Renewable Energy Regulatory Framework and Policies, Solar developers under the Jawaharlal Nehru National Solar Mission (JNNSM), Moser Baer studies, SPV cell technology and Balance of Systems. Also included was a detailed session on low and medium temperature solar collectors. In the wind energy area, sessions included discussions on increasing the wind power potential, the challenges, technology developments, certification and site identification. There were detailed sessions on various bio energies and waste to energy recovery systems. On the sidelines of the Conference a college education fair for students and a mega competition on 'Innovative ideas on Renewable Energy for college students' were also organised. The Conference was attended by scores of engineering college administrators and decision makers from all over Tamil Nadu. Over 20 country representatives participated in the event.

The VaVoVa 2011 was aimed at bringing together various consultants, industry experts, policy makers, vendors and manufactures along with project developers on a single platform. ✪

NATIONAL CONFERENCE ON GREEN DESIGN: BUILDINGS AND HABITATS

The conference brought together building industry professionals from across varied disciplines.

The National Conference on Green Design: Buildings and Habitats was held on 7 and 8 January 2011 at New Delhi. It was organised by the Ministry of New and Renewable Energy (MNRE), Association for Development and Research on Sustainable Habitat (ADaRSH) and The Energy Research Institute (TERI). Speaking at the inaugural session, Dr Farooq Abdullah, Hon'ble Minister of New and Renewable Energy said, "We are greatly interested that new buildings should be energy efficient and aesthetically beautiful. While planning, regional conditions must be taken into consideration. It is vital to find out what can be done to make the process easier." During the sessions, eminent architects, government officials, construction management professionals, planners and engineers; both Indian and foreign, provided solutions for a greener future. While in his address Shri Deepak Gupta, Secretary, MNRE said, "India is already witnessing a process of rapid urbanisation. This will lead to a tremendous energy demand in urban areas. Thus keeping in mind our climatic conditions, a National rating system - the Green Rating for Integrated Habitat Assessment (GRIHA) has been developed." Following the speech, plaques were awarded to GRIHA certified projects. On the sidelines, the Conference hosted an exhibition showcasing green building products, energy efficient solutions, new technologies and services available to build a sustainable habitat. Big corporate houses and multinational companies presented their efforts in enterprise development for greener built up structures. On the second day a high level ministerial session on policy and imperatives for green building design was held, where the role of the central government in green design and green buildings was presented by Prof Saugata Roy, Hon'ble Union Minister of State for Urban Development. Dr R K Pachauri, Director General, TERI and President ADaRSH pointed out that efforts for a greener future should be taken up at the earliest as "buildings do not expand their footprints ecologically".

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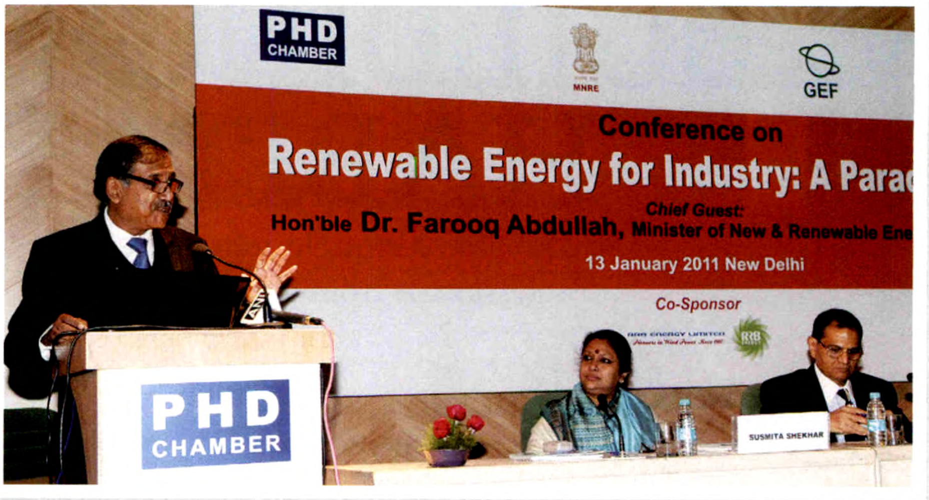
Enabling Industry and RE dialogue

Investments in the renewable energy sector have soared with rapidly growing generating capacities as well as manufacturing capabilities.


PHD CHAMBER
MNRE
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Conference on
Renewable Energy for Industry: A Parad
Chief Guest:
Hon'ble Dr. Farooq Abdullah, Minister of New & Renewable Ene
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SUSMITA SHEKHAR

'Industry should focus on green buildings...' Shri Deepak Gupta, Secretary, MNRE

A conference on 'Renewable Energy for Industry: A Paradigm Shift' was organised by the PHD Chamber in New Delhi on 13 January 2011. Speaking at the inaugural session Shri Deepak Gupta, Secretary, Ministry of New and Renewable Energy (MNRE), said that to save power and promote renewable energy, the industry should be committed to setting up green buildings in the future; this set the theme for the subsequent proceedings of the Conference.

Shri Gupta also added that the government is ready to extend all possible help in setting up green buildings and solar installations. While the industry is aggressively involved in the development of renewable energy, particularly wind power, biomass power, bagasse cogeneration and small hydro power, some of the large industrial groups and small and medium enterprises are also entering this emerging sector.

"We need combustion based captive energy plants of 1 to 2 MW. There is a huge scope for cogeneration mode where the industry can put renewable sources of energy along with conventional sources to good and efficient use. Greater reliance on renewable energy will result in a ecologically sustainable growth. This will also reduce waste and health hazards. We need efficient waste management systems and more waste treatment plants," reiterated Shri Gupta.

He added, "Solar energy has a vast potential, but a lot needs to be done on this front. The government expects to see the deployment of 20,000 MW of solar power by 2022. The industry should install more solar heaters. Many companies are using solar heaters with good results and saving fossil fuels. MNRE is aggressively promoting rooftop solar systems and providing incentives." Investments in the renewable energy sector have soared with rapidly growing generating capacities as well as manufacturing capabilities. Venture capital and private equity investments in the sector have also been growing. Debt financing is provided by commercial banks and leading financial institutions in the power and infrastructure sectors. Indian Renewable Energy Development Agency (IREDA) the corporate financing arm of the Ministry is providing sustained financing support to the sector. ✪

What's that?

Here is an exercise that is intended to introduce you to a gamut of technical terms on solar power that can catch you unawares.

Amorphous silicon: An alloy of silica and hydrogen, with a disordered, non-crystalline internal atomic arrangement, that can be deposited in thin layers (a few micrometers in thickness) by a number of deposition methods to produce thin-film photovoltaic cells on glass, metal, or plastic substrates.

Solar Cell: A solar cell (also called photovoltaic cell) is a solid state device that converts the energy of sunlight directly into electricity by the photovoltaic effect. Assemblies of cells are used to make solar modules, also known as solar panels.

Electricity Grid: An electrical grid is an interconnected network for delivering electricity from suppliers to consumers.

Series regulator: A type of battery charge controller or regulator in which the charging current is controlled by a switch, transistor, or field-effect transistor connected in a series with the PV module or array.

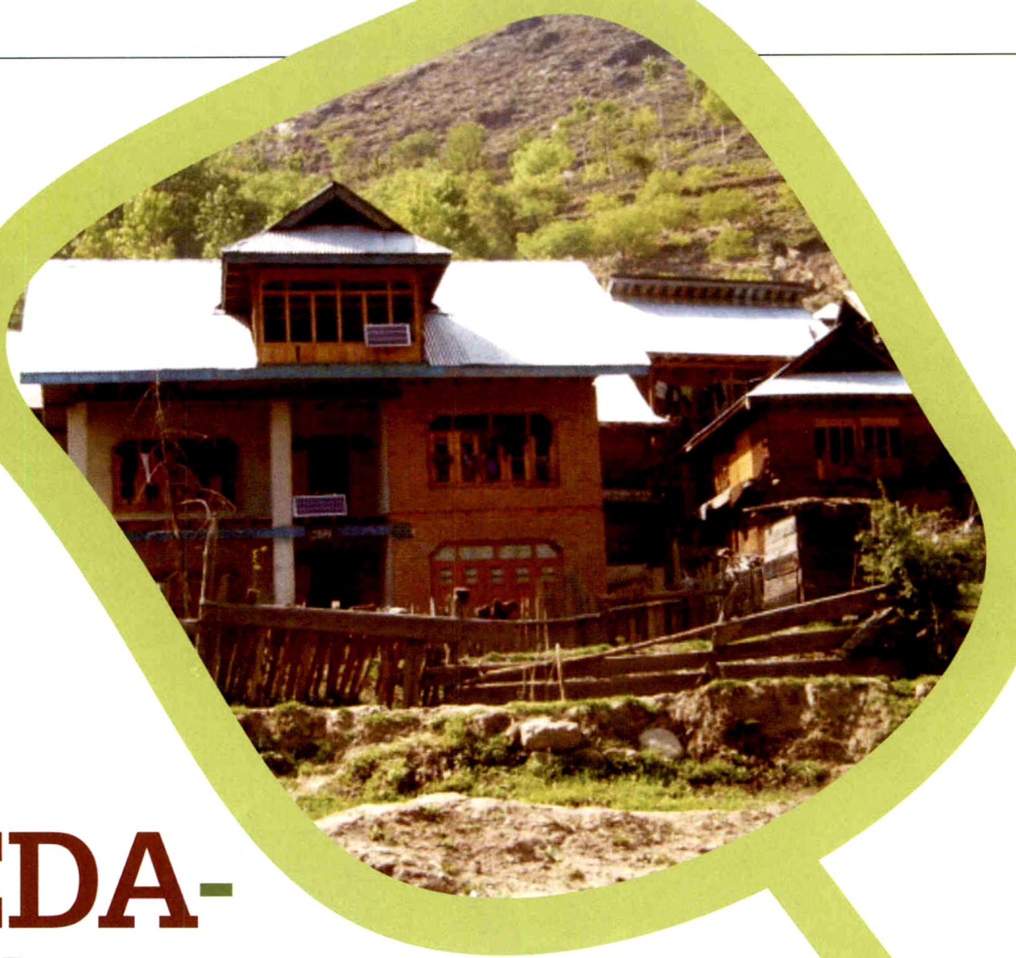
Passive Solar: A system in which solar energy alone is used for the transfer of thermal energy. Pumps, blowers, or other heat transfer devices that use energy other than solar are not used.

Thermo-siphon System: Refers to the solar collector system for water heating in which circulation of the collection fluid through the storage loop is provided solely by temperature and density difference between the hot and cold fluids.

Energy Star: Energy Star is an international standard for energy efficient consumer products, which originated in the United States of America. It was first created as a US government programme during the early 1990s. Later Australia, Canada, Japan, New Zealand, Taiwan and the European Union have also adopted the programme.

Semi-conductor: A material that has an electrical conductivity in between that of a metal and an insulator. Transistors and other electronic devices are made from semi conducting materials, and are often called semiconductors. Typical semiconductors for PV cells include silicon, gallium arsenide, copper indium diselenide, and cadmium telluride.

Single Crystal Silicon (Czochralski): An extremely pure form of crystalline silicon produced by the Czochralski method of dipping a single crystal seed into a pool of molten silicon under high vacuum conditions and slowly withdrawing a solidifying single crystal boule rod of silicon. The boule is sawed into thin wafers and fabricated into single-crystal photovoltaic cells.



JAKEDA- Lighting up remote villages

One of the objectives of Jammu and Kashmir Energy Development Agency (JAKEDA) is to promote and implement projects aimed at meeting the energy requirements of remote and unelectrified areas of the State by harnessing new and renewable sources of energy.

By **S S Marazi**

Jammu and Kashmir, the northern most state in India, has some of the most beautiful landscapes in the country - but due to the geography and the current political situation, parts of the State remain inaccessible. Developing conventional infrastructure has been a challenge in the remote parts and electrification is one aspect of infrastructure that has faced problems in the inaccessible areas. The laying down of power transmission and distribution lines is not feasible in some cases due to the difficult terrain and the huge financial implications.

Considering that electricity is a much needed commodity, the government has looked for alternate means to provide the inhabitants of these remote areas with basic lighting facilities. One solution to addressing the problem in the State, is the solar home lighting project under the Remote Village Electrification (RVE) programme of the Ministry of New and Renewable Energy (MNRE), Government of India, being implemented by the Jammu and Kashmir

Energy Development Agency (JAKEDA).

JAKEDA is a State Nodal Agency (SNA) working under the administrative control of the Science and Technology Department, Jammu and Kashmir Government. It works for the promotion and implementation of projects aimed at meeting the energy requirements of the state in general and unelectrified areas in particular by harnessing new and renewable sources of energy such as solar, wind, biomass and small hydro. JAKEDA gets funds from MNRE as well as the State government for implementation of various projects in the State.

As part of the RVE programme, 1500 solar home light systems (SHLS) were installed in the Machil area of Kupwara District and 1052 SHLS in the Padder Block of Doda District of the State during the period 2006-07.

The modus operandi for implementation

As a first step, the unelectrified census villages and the remote hamlets of electrified census villages are identified. During 2008-09, in the Kashmir division a total of 68 such unelectrified villages and 67 unelectrified hamlets were identified for proposed coverage under the RVE programme. The Kashmir division covers the ten districts of Anantnag, Bandipora, Budgam, Baramulla, Ganderbal, Kupwara, Pulwama, Shopian, Kulgam and Srinagar. While in Jammu division the exercise identified a total of 41 such unelectrified villages and 1396 unelectrified hamlets for the same period. The Jammu division comprises the nine districts of Udhampur, Doda, Rajouri, Poonch, Jammu, Kathua, Ramban, Kishtwar and Reasi.

Next, a certification is obtained from the concerned power department/State Electricity Board (SEB), MNRE and the Renewable Energy Certificate (REC), GoI. The list of villages identified in both Kashmir and Jammu divisions in 2008-09 has been submitted by JAKEDA for the necessary vetting

A project report is then prepared by a consultant and the report is submitted to MNRE for obtaining the sanction and central financial assistance (CFA). Other means of finance are also explored. Finally when all aspects are in place the scheme can be implemented. The logistical support for the implementation is provided by the respective district authorities.

Remote Village Electrification

SHLSs were distributed in four areas of Kashmir division and three areas of Jammu division under the RVE Programme 2003-04, which was actually implemented in 2007-08 (Table 1). The target was to install a total of 8,297 SHLSs and the entire cost was estimated at Rs 1047.66 lakhs. This cost was to be shared by MNRE, the State and the beneficiaries.

SHLs distributed under RVE programme 2003-04

Kashmir Division		
S. No.	**Area**	**Households benefited**
1.	Kandi Kupwara	1156
2.	Jumagund	185
3.	Machil	1870
4.	Keran	1265
	TOTAL	**4476**
Jammu Division		
1.	Padder	1053
2.	Warwan	1025
3.	Marwah	1743
	TOTAL	**3821**

Kupwara District

Parts of Kupwara District border the Line of Control (LoC) in the thick of the Karakoram forests. The areas remain snowbound and 'cut off' for almost six months in a year and include: Machil, Keran, Kandi (Kupwara) and Jumagund. JAKEDA has provided 4,476 SHLSs in as many households, transforming the socio-economic scenario of the area. A total of 24 villages were covered and the cost of the project was Rs 565.18 lakhs. Out of this MNRE and the beneficiaries contributed Rs 429.25 and 33.57 lakhs, respectively, while the share of the State amounted to Rs 102.37 lakhs.

Kishtwar district

The mountainous terrain of Kishtwar district shares a border with Chamba district of Himachal Pradesh in the south. The remotest blocks of the district include Padder, Warwan and Marwah. The inhabitants from these blocks have to walk more than 50 kms on 'pony roads' to connect to a metal road. Here, JAKEDA has been successful in providing 3,821 SHLSs in as many households, helping to solve their basic lighting problem. Covering 26 villages the project cost was Rs 482.48 lakhs, of which MNRE and the beneficiaries contributed Rs 366.43 and 28.66 lakhs, respectively, while the State's share amounted to Rs 87.38 lakhs.

The programme undertaken by JAKEDA has been a huge success and has generated a tremendous response in the districts of Kupwara and Kishtwar, particularly in the blocks of Machil and Padder. ❂

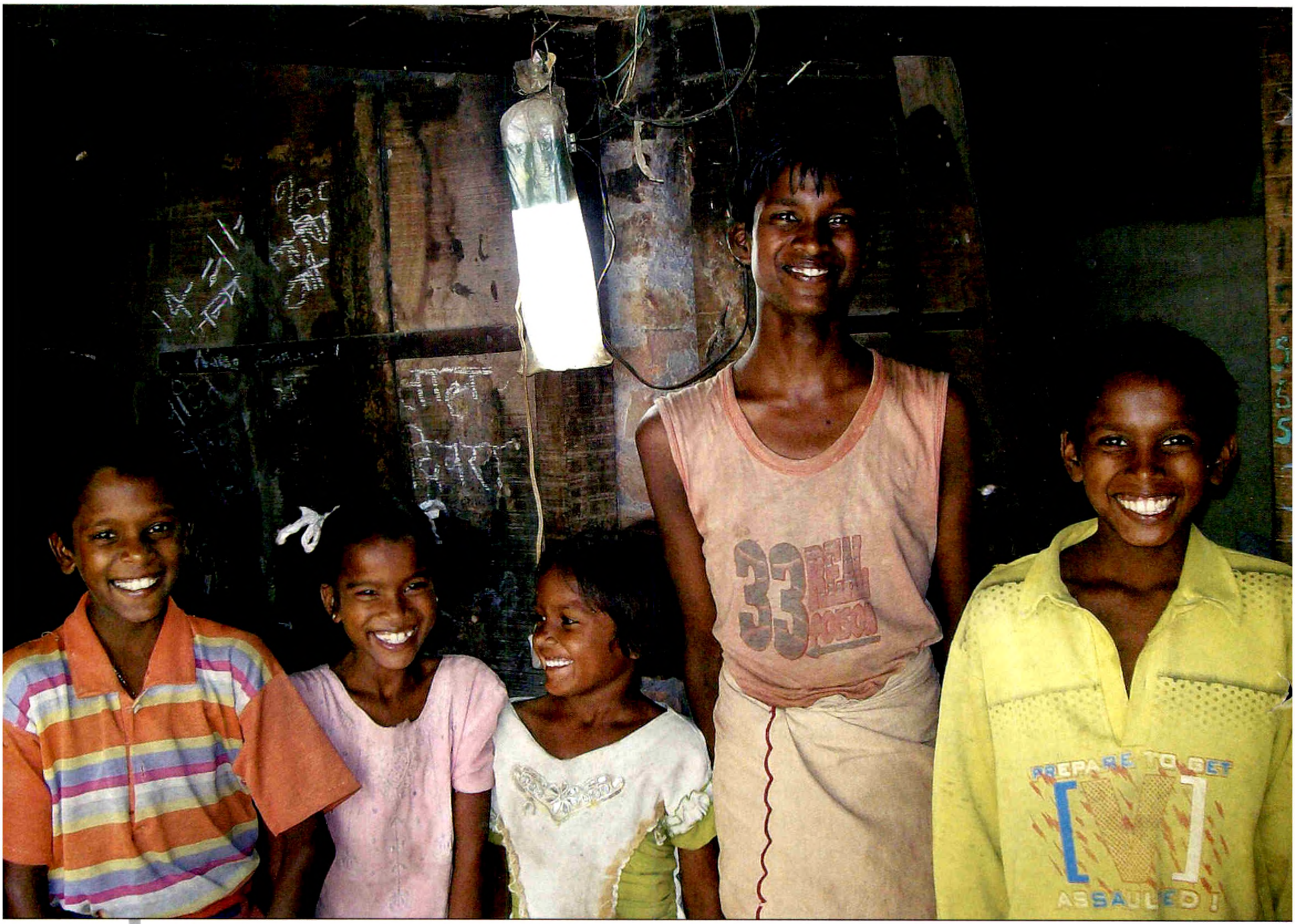
The author is CEO of Jammu and Kashmir Energy Development Agency (JAKEDA).

A BRILLIANT START

The Solar Mission

The Ministry of New and Renewable Energy (MNRE) has done commendable work in terms of conceptualising, drafting, launching, and implementing the Jawaharlal Nehru National Solar Mission over the last one year.

By **Anil Patni**



The year 2010 will be marked as the year when Jawaharlal Nehru National Solar Mission (JNNSM) was launched in all earnestness. The Mission has already started showing signs of great promise for the future - in terms of upscaling and mainstreaming the use of solar energy as a sustainable source to address the intertwined issues of enhancing India's energy security and helping mitigate global warming and climate change. The JNNSM targets of generating 20,000 MW of grid connected and 2000 MW of off grid solar power by 2022 are truly impressive. By following the global experience of connecting solar power to the grid through megawatt scale solar power plants, India has joined the global solar bandwagon in a big way.

Teamwork by government agencies

The Ministry of New and Renewable Energy (MNRE) has done commendable work in terms of conceptualising, drafting, launching, and implementing the JNNSM over the last one year along with the Ministry of Power (MoP). The National Thermal Power Corporation (NTPC) has played a key role through the NTPC Vidyut Vyapar Nigam (NVVN) in organising the short listing of the applicants for setting up large solar projects in Phase 1 of the JNNSM (January 2010 - March 2013). Similarly, the Indian Renewable Energy Development Agency (IREDA) has played a vital role as the nodal agency for selection of applicants for the up to 2 MW capacity, rooftops PV and small solar power generation programme (RPSSGP). Of course, all these initiatives would not have been possible without the pivotal role of the Central Electricity Regulatory Commission (CERC) which came out with a levelised tariff for the solar power plants. This became the basis for the solar tariff set by the State Electricity Regulatory Commissions (SERCs) and in many cases the SERCs decided to emulate the CERC tariffs.

It is laudable that all these government ministries and agencies worked in tandem to launch the first set of large commercial plants under the JNNSM and it is creditable that we have some 900 MW of solar power plants already underway in the first year of the Solar Mission.

Technology allocation

MNRE suggested allocation of 60 per cent of the projects in the Mission for concentrated solar thermal (CST) and 40 per cent for solar photovoltaic (PV) technology, in its effort to try out other technologies. After discussion with the Indian solar industry, the government has adjusted the allocation to 50-50 between thermal and PV. In India, the PV technology has established itself over the past two decades and there are some 40 manufacturers of solar PV modules in the country today. In comparison CST technology is yet to develop a manufacturing base. The Government can validate CST in the Indian context by way of demonstration projects and subsequently on a commercial scale. While there are specific advantages for PV, such as its ability to be applied at micro scale in terms of individual products like solar home lights and lanterns as well as at rooftop PV systems and megawatt scale plants; CST also has its advantages such as its capability to hybridize with gas and other sources and the capacity for power storage, though the costs for storage are prohibitively high at present.

NVVN bidding

The government went for reverse bidding for the 5 MW PV projects totalling 150 MW and for the 10-100 MW CST projects totalling 470 MW. The bidding was organised by NVVN based on highest discount offers. This resulted in aggressive bidding and the resultant tariffs of Rs 11 to 12.50 per kWh are as much as 30-40 per cent lower than the CERC tariff of Rs 17.91, which was set after due diligence and taking into account the Indian and global solar industry data as well as discussion in an open public hearing. The aggressive bidding has enabled new enthusiastic players to enter the Indian solar market, who can seek assistance from the Ministry and banks for funding as well as technology, for the success of the JNNSM. The Ministry may look at addressing the gap in solar tariff in the next round of bidding. CERC tariffs for the whole country can be adjusted region wise such that eastern and north eastern parts of India also receive solar investments.

Made in India

The Ministry has mandated use of indigenous PV modules in Phase 1 of JNNSM. This proviso will be extended to the use of indigenous cells in the next phase. The move has been

> **Hopefully, 2011 will be the year when solar products and systems will become a consumer item, which can be bought off the shelf in shops and markets.**

100 kW Tangtse Solar Power Plant, Ladakh

welcomed, since it gives a level playing field to the Indian PV manufacturing industry. The proviso applies to the use of crystalline silicon (C-Si) modules - an established technology accounting for 85 per cent of the global market. However, import of non C-Si modules like thin film (amorphous silicon, cadmium telluride etc.) have been possible. This has led to a situation where the overstretched-for-low-cost projects in the NVVN list may import thin film technology without considering the long term sustainability and performance guarantee of the projects. The provision is necessary to attract further investments for the manufacturing of solar PV into India. The numerous announcements made by Indian and foreign players to start PV manufacturing in India show that the move is in the right direction. The state governments, which are implementing ambitious solar power plans, should be encouraged to include a 'Made in India' clause in their respective policies.

Off grid

The Ministry's idea to create a range of channel partners like system integrators, banks and micro finance institutions (MFIs), NGOs, financial integrators and renewable energy service companies, apart from the State Nodal Agencies (SNAs), to implement off grid projects and obtain subsidy directly from the MNRE is a good one. It augments the process of implementation of the off grid segment of the JNNSM which foresees a target of 200 MW in Phase 1 and 2000 MW by 2022. These channel partners will have to get themselves rated or accredited through agencies appointed for the purpose (CRISIL or ICRA etc.) and based upon the rating they can submit their project proposals. Each project proposal can accumulate different off grid initiatives totalling 1 MW at a time. This is a sound idea to effectively and efficiently get projects implemented. However, the critical factor for success will be the speed and ease with which the channel partners get their payment from the government. One suggestion is to make the entire transaction online, including submission of project proposal to MNRE's committee, tracking of the application, and finally payment of the subsidy to the channel partner/ beneficiary - so that human interface and consequent delays are eliminated.

Off grid and decentralised renewable energy applications are the most appropriate for a vast and rural country like India where the grid cannot be extended everywhere. We have the successful example of Chhattisgarh where almost 900 village level micro plants are running on solar energy for the last 2 to 3 years. This model can easily be extended to the neighbouring states of Bihar, Jharkhand and Orissa where the conventional electricity supply in rural areas is similarly hindered. Further, there is the example of Uttar Pradesh where one company has sold more than 1,10,000 solar home lighting systems. This can be amplified to cover all unelectrified households in the country. This is sought to be achieved by roping in regional rural banks through the National Bank for Agriculture and Rural Development (NABARD) - another welcome step.

Capacity building, research and development

The inaugural year of the JNNSM was perhaps rightly spent in getting the first batch of projects off the ground but in its second year the Mission must focus on some core and essential areas such as capacity building and promoting research and development. The MNRE has recently prepared a human resource development plan for the renewable energy sector. This should be implemented in earnest through close cooperation with the Indian industry because shortage of trained and skilled manpower is already being felt by the Indian solar industry due to its current relatively small size.

One of the most important targets for JNNSM is to achieve grid parity of solar power by 2022. This is sought to be accomplished by generating large volumes to drive down costs by bringing in the play of economies of scale in manufacturing and project implementation. The second aspect of this strategy has to be result oriented technological research and development. The JNNSM document talks about setting up a national council to promote solar research. There is no doubt that there is a need to enhance the level of research to find new materials, improve efficiency of the existing ones, reduce the cost and improve the efficiency of balance of systems (BOS), optimise solar power through tracking mechanisms and make storage of power cost effective and long lasting etc. The government can come out with another policy like the Special Incentive Package Scheme (SIPS) which allows for 20-25 per cent grant for the setting up of solar PV manufacturing, subject to a minimum investment of Rs 1000 crore. The new policy should be pegged at lower threshold levels and must include polysilicon and wafer manufacturing as well as BOS.

1 MW NDPL solar PV array

> **Off grid and decentralised renewable energy applications are the most appropriate for a vast and rural country like India where the grid cannot be extended everywhere.**

Hopefully, 2011 will be the year when solar products and systems will become a consumer item, which can be bought off the shelf in shops and markets. For this to happen, it is essential that the respective regulatory agencies fix solar rooftop tariffs and the respective state governments extend support in the form of capital subsidies to make rooftop solar power systems affordable. If this is done in mission mode, individual consumers will be incentivised to start setting up their own rooftop solar power plants, as has been the experience in Germany. This idea could help solve the current problem of 12 per cent demand supply gap in the power sector.

Road ahead

The first year of the Solar Mission has been an eventful one. We need to keep up the momentum with the immediate goal being the timely and successful achievement of the Phase 1 targets and the next goal being to prepare for Phase 2 based upon the experience and learning from Phase 1. If all of us, from the industry and government join hands with a positive and proactive approach, we can surely achieve it. ✪

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Solar PV and integrated devices

towards achieving the Solar Mission goals

The role of appropriate solar devices for multiple uses would enable supplementation of a huge supply of energy on one hand and on the other help in achieving some of the goals of Jawaharlal Nehru National Solar Mission (JNNSM) while equipping the rural masses simultaneously for a better livelihood.

By **Dr P C Pande**

JNNSM aims at deploying 20000 MW of solar power by 2022, an apt and marvellous plan. However, it cannot be based only on the installation of solar thermal or photovoltaic (PV) plants with certain concessions. The role of appropriate integrated solar devices capable of varied usage would enable supplementation of a huge supply of solar energy on one hand and

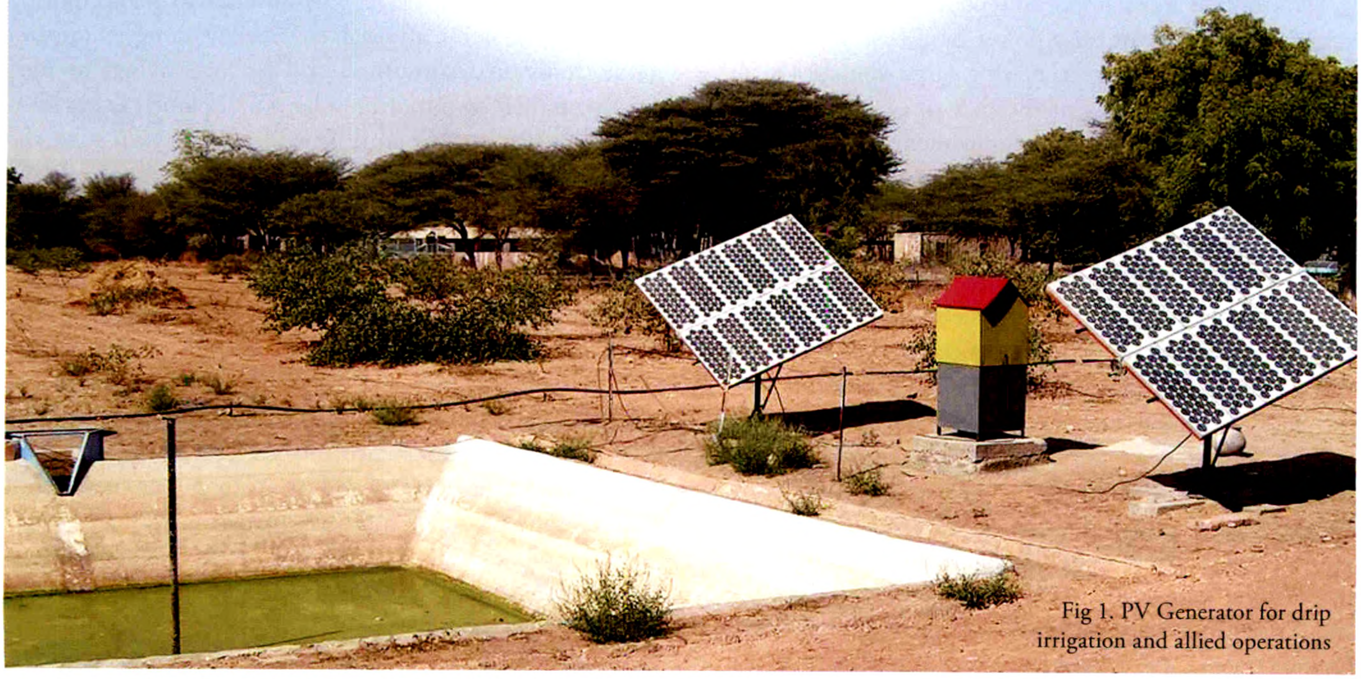


Fig 1. PV Generator for drip irrigation and allied operations

on the other help in achieving some of the goals of the JNNSM while equipping the rural masses with a better livelihood. Although, use of a few solar devices like water heaters, solar lighting systems etc., have been considered, there are several other applications that relate to the rural economy and are useful from the farmers' perspective. In this connection the outcome of extensive work, carried out at the Central Arid Zone Research Institute (CAZRI) bears relevance. Different solar thermal devices like solar water heaters, cookers, stills, dryers, polish making machines and PV systems for rural and agricultural applications have been developed and evaluated earlier at CAZRI. Of late the focus has shifted to the development of integrated multipurpose solar devices to enhance utility and practicability. A few novel PV systems and integrated solar devices designed and developed by the author are enumerated here. These multipurpose integrated solar devices may be considered as a part of the programme to quench the much needed energy thirst, especially in rural India.

Three-in-one solar integrated device

This unique integrated solar device (Fig 2) can be used as a solar water heater during the winter, a solar cooker during clear days and a solar dryer for fruits or vegetables. It can produce about 50 lt of hot water of 50-60°C utilising the low altitude position of sun during winter and food for a family can be boiled within 2-3 hours, when used as a solar cooker and that too without sun tracking. As a dryer, fruits and vegetables can be dehydrated efficiently with regulation of temperature during the day with water working as a sink regulating temperature and helps continuation of the drying process in the night through the solar heated water.

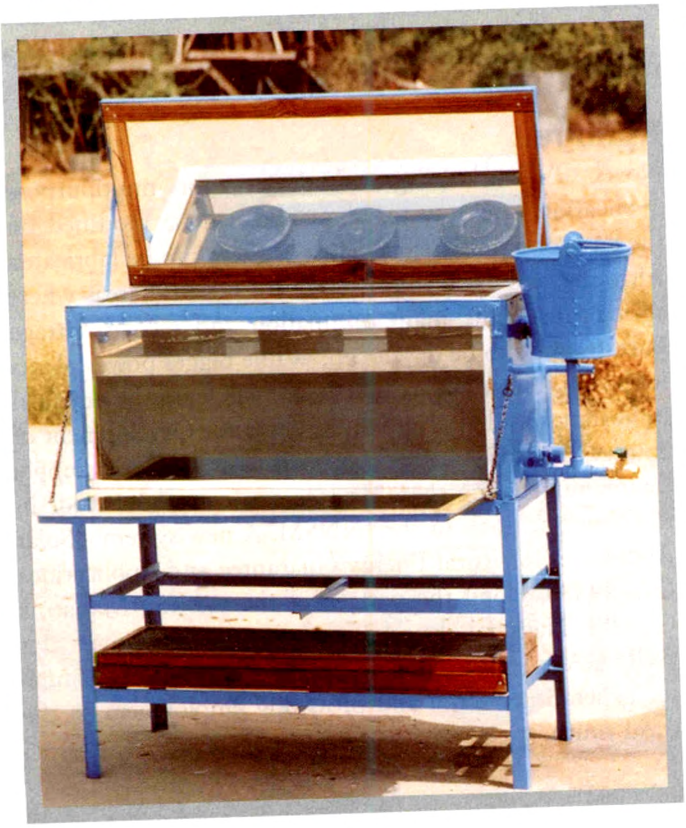


Fig 2. Integrated triple purpose solar device

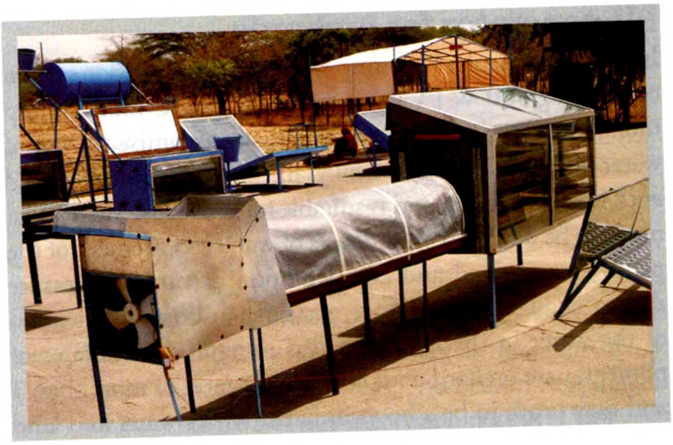


Fig 3. PV winnower cum dryer

PV winnower cum dryer cum illuminating system

Solar PV winnower cum dryer (Fig 3) is a convenient device for winnowing threshed agricultural produce, especially during the period of lull in natural winds and also for dehydrating fruits and vegetables with forced circulation of air. The system comprises a PV module, a compatible winnower, a pre-air heating tunnel, a especially designed solar drying cabinet with proper interconnections to use the fan of the winnower for enhanced air circulation while dehydrating the produce. Used as a winnower 35-50 kg of cleaned grains/seeds can be obtained in one hour from this device.

In addition, different fruits and vegetables can be dehydrated in less than half the time as compared to open sun drying. The enhancement in the fan speed with more irradiance regulates the temperature while the pre-air heating in the extended tunnel reduces the thermal gradient inside the drying cabinet. Thus excellent quality of the dried material is achieved with the retention of aroma and colour. The system can be provided with additional features for illumination with incorporation of a battery and charge regulator, thus making it an extremely useful device for processing different agricultural produce and utilising the generated PV electricity for one or another purpose throughout the year.

grid connected solar power projects. After evaluation of the received applications, short listed solar power project developers were informed and their bids were opened on 16 November 2010. The eligible bids offered a range of discounts and the average rate for selected plants was Rs 12.16 per unit for solar PV and Rs 11.48 per unit for solar thermal plants. NVVN had invited bids for 620 MW capacity (see table) and had shortlisted 30 solar power project developers for 150 MW of solar PV capacity and 7 solar power project developers for 470 MW solar thermal capacity. Letters inviting expression of interest (EoI) from various state utilities/discoms for purchase of solar power under Phase 1 of JNNSM have been sent out in November 2010. As on 11 January 2011 power purchase agreements of 800 MW capacity have been signed with investors and implementation is underway.

List of projects selected under JNNSM Phase 1 Batch 1 by NVVN

State	Solar project type	Capacity (MW)
Maharashtra	PV	5
Rajasthan	PV & thermal	505 (105 PV & 400 thermal)
Karnataka	PV	10
Andhra Pradesh	PV & thermal	65 (15 PV & 50 thermal)
Uttar Pradesh	PV	5
Tamil Nadu	PV	5
Orissa	PV	5
Gujarat	Thermal	20
Total		**620**

Future perspective

NVVN will play a very important role in the implementation of JNNSM in the years to come. NVVN has several competitive advantages, which include;

- It is promoted by NTPC Limited, one of the biggest energy operators in the country. NTPC has an excellent track record in creating energy infrastructure in India and provides a strong managerial, technical and financial background to NVVN.
- It has an excellent asset back up - NTPC's existing capacity is 32694 MW and it plans to be a 50,000 MW plus entity by 2012 and a 75,000 MW company by the end of 2017.
- NTPC has a strong network with existing utilities, which is one of the important drivers in the trading industry. This helps NVVN to easily establish rapport and credibility with potential buyers and sellers.
- NVVN being a 100 per cent owned subsidiary of NTPC Limited, is also a government company under the Companies Act 1956. NVVN would thus enjoy strong credibility in the market.
- NVVN employees have been drawn from the professional manpower of NTPC. Most of them are engineers and charted accountants having extensive experience in dealing with various technical and commercial issues in NTPC.

With the government having done its bit, now it is up to the industry to make India the solar capital of the world, in the years to come. ❂

The author is from the Climate Change Mitigation Unit, German International Cooperation (GIZ)

Solar COOKER

Simple things which are readily available around the house can be used to create a solar cooker. In your 'do it yourself' solar cooker you can cook a delicious meal without lighting a match.

Do you fancy an exotic meal cooked for several hours under the hot blazing Indian sun? Well, here is how to go about it. Visit your nearest grocer and get hold of two reasonably large cardboard boxes - a size that can hold two large bowls with some room to spare. One box should fit into the other. Collect and crush a few old newspapers, better still if you can get some straw. These will be used for insulation.

Now, the tricky part - the lid of the inner box. You will need a transparent glass cut to the dimensions of the top of the box. Besides the above, check that you have all the materials listed in the box alongside. Now you can sit down to assemble and create your very own solar cooker.

The inner Box. Clean out the box, tape up all the sides except the top. Ensure that the box is sturdy. With a pair of sharp scissors cut off the top four top flaps of the inner box. Tape up the rough edges. Now, paint the inside of the box a very very dark black - preferably using acrylic paint. Leave the box to dry.

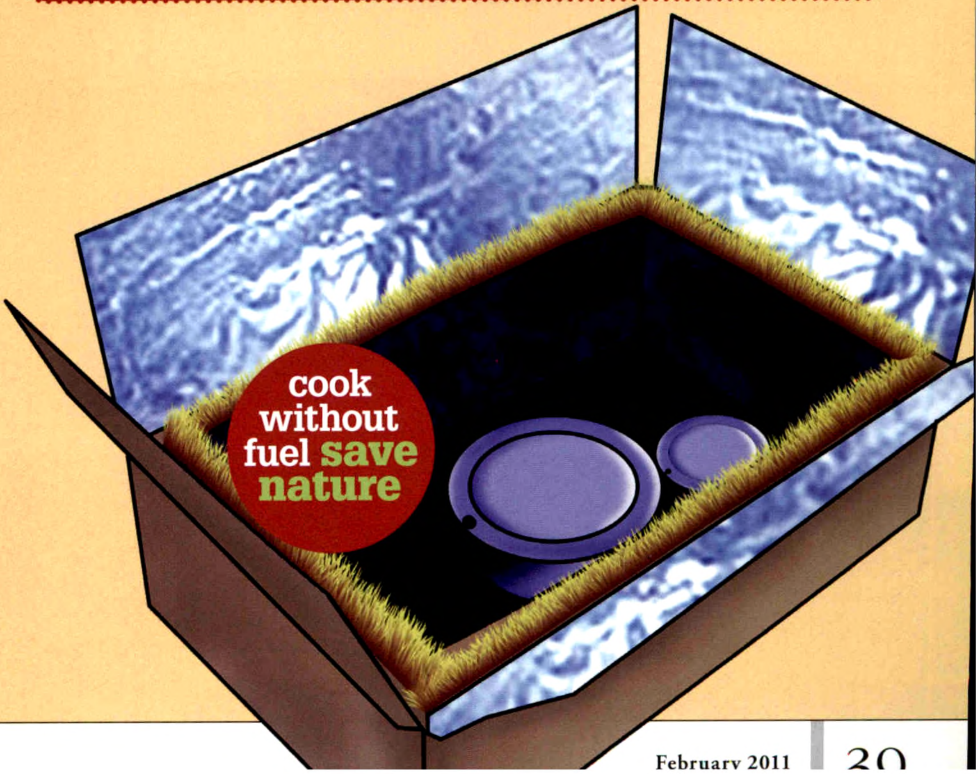
The outer box. Clean out the box, tape up all the sides except the top. Ensure that the box is strong. With the scissors cut out large pieces of aluminium foil - the kind that is used to wrap food. Paste the pieces on the inner side of the four top flaps. Leave the box to dry.

The insulation Use materials that are poor conductors of heat - rolled up newspaper, straw, husk etc. Place a layer of this material at the bottom of the big box and then place the smaller box on top. Next, fill out the gaps between the four sides of the boxes tightly with insulation material. Once this is done the two boxes should become one unit.

The glass top Place the glass top on the inner box. You are now all set to make a delicious meal with your very own solar cooker.

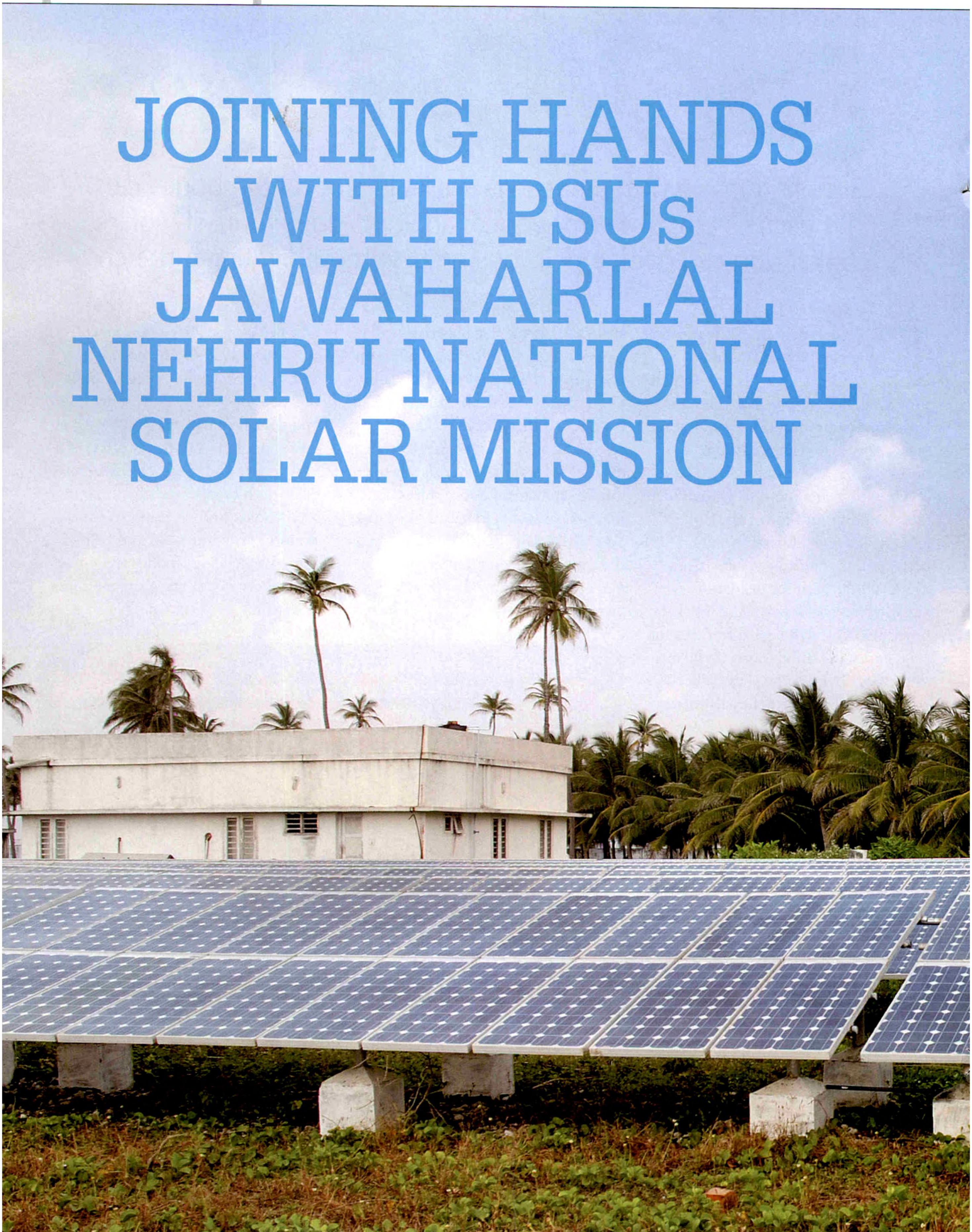
The meal Select two non reflective bowls with lids. In one bowl put half a cup of washed rice and pour two cups of water. In the other bowl mix your favourite vegetable with a spoonful of oil, salt to taste, a pinch of turmeric and green chillies. Place both bowls carefully in your solar cooker and set it out in the sun. Wait for two hours - lo and behold you have delicious food ready, cooked only with the pure goodness of nature.

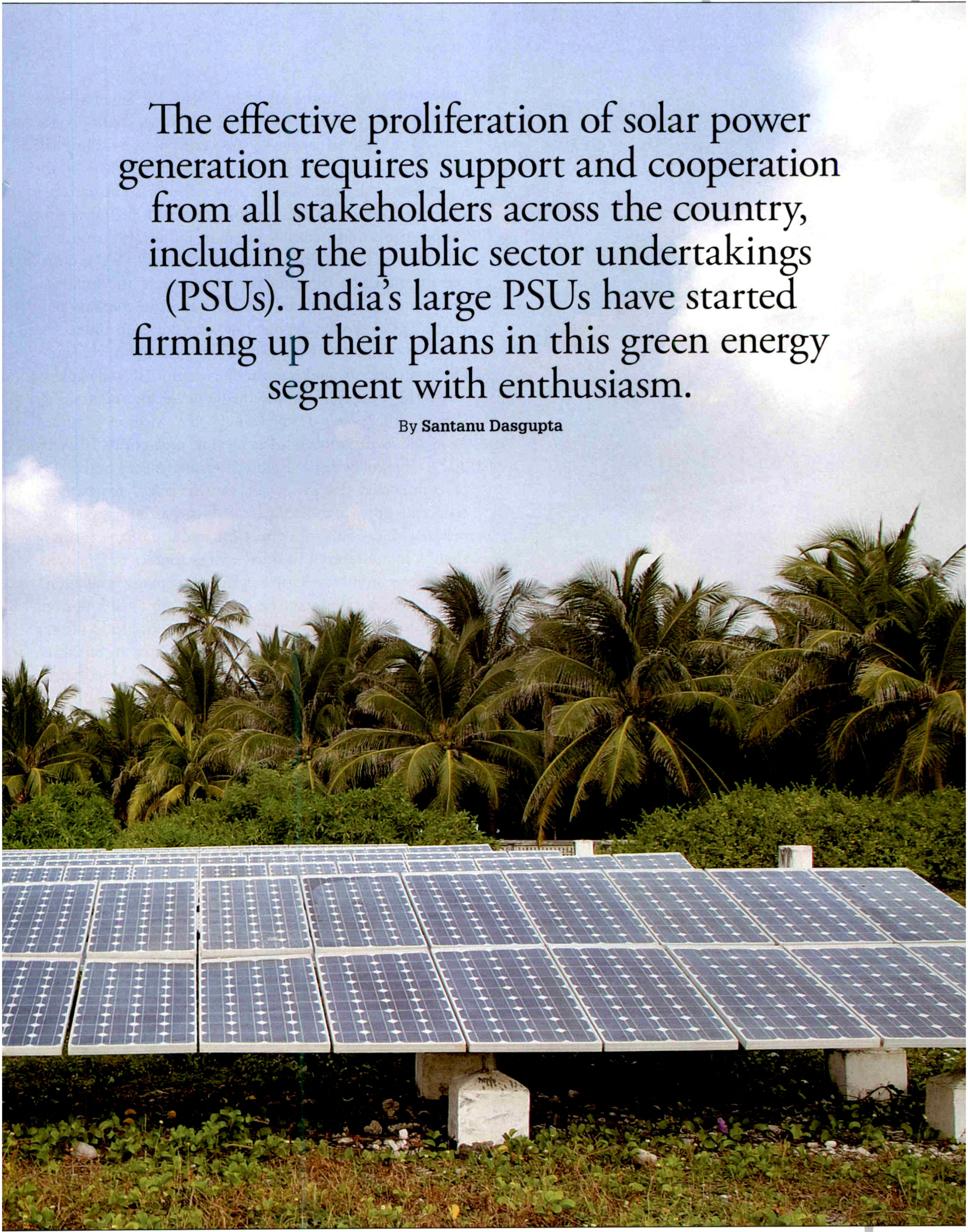
1 big and 1 smaller cardboard box; aluminium foil; black acrylic paint; packing tape; scissors; glass sheet; 2 aluminium bowls with metal lids; half bowl rice; vegetable of choice and spices.



cook without fuel save nature

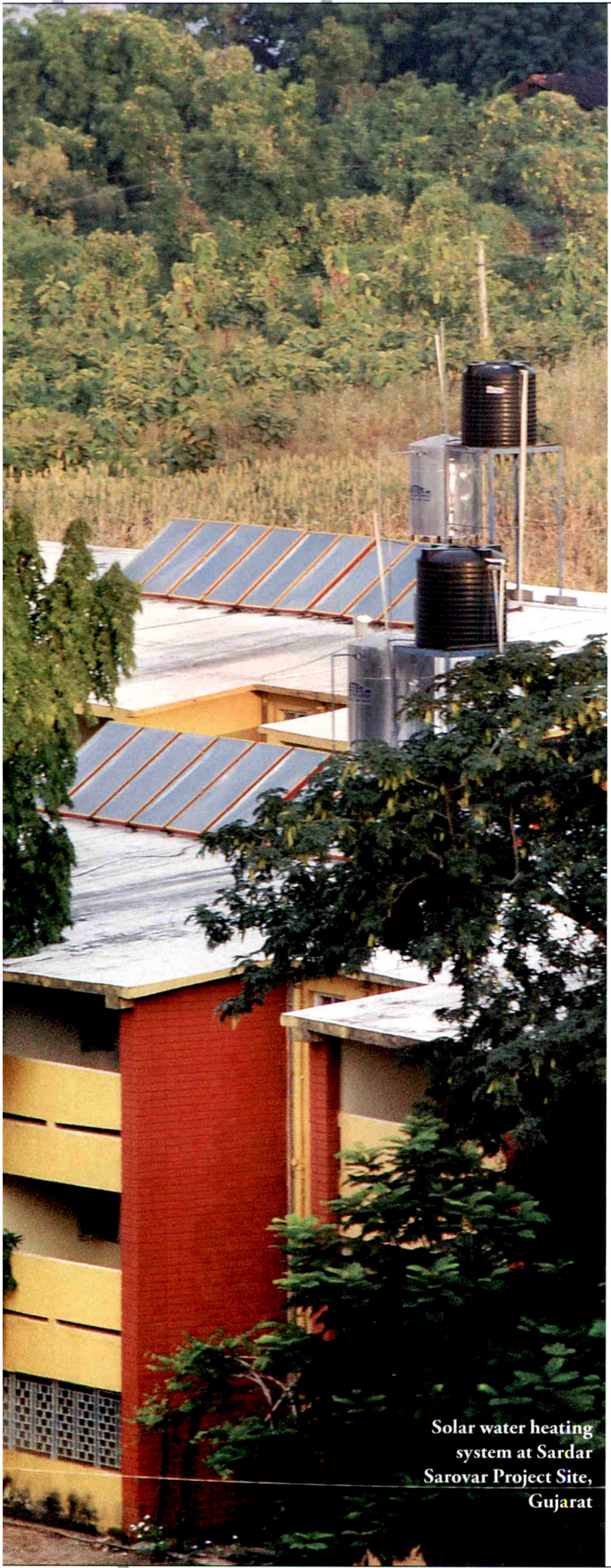
JOINING HANDS WITH PSUs JAWAHARLAL NEHRU NATIONAL SOLAR MISSION





The effective proliferation of solar power generation requires support and cooperation from all stakeholders across the country, including the public sector undertakings (PSUs). India's large PSUs have started firming up their plans in this green energy segment with enthusiasm.

By **Santanu Dasgupta**



Solar water heating system at Sardar Sarovar Project Site, Gujarat

The Jawaharlal Nehru National Solar Mission (JNNSM) is poised to crown India as the global leader in solar energy, by enabling the policy to diffuse across the country in the shortest possible time. The Mission has set a target of 20000 MW and proposes to meet it in 3 phases for various items under consideration, including grid connected solar power. The effective execution of the JNNSM requires the identification of resources to overcome the financial, technological, institutional and other obstacles that may pose challenges to the development of solar power in India. The effective proliferation of solar power generation, therefore, requires support and cooperation from all stakeholders across the country, including the public sector undertakings (PSUs). The policy framework of the Mission is aimed to facilitate the process of achieving grid parity latest by 2022. The policy further aims at uninterrupted availability of commercial energy at competitive prices for national economic growth and to meet at least partially the energy needs of households with safe, clean and sustainable forms of energy. In addition, diversified energy sources of renewable energy can promote multiple options for energy generation.

Solar energy appears to be one of the most viable options in the Indian scenario, since India is a tropical country blessed with abundant medium to high intensity sunshine for long hours per day. Further, decentralised distribution of energy is a natural derivative of development of solar alternatives that can aptly empower people even at the grassroots level. The challenging task of implementation of the JNNSM is entrusted to the Ministry of New and Renewable Energy (MNRE), Government of India.

Thus solar energy in India is poised to be one of the most formidable opportunities in the 21st century for the energy sector. Combining the government's strong initiative with India's locational advantage for solar energy presents a win-win combination. The other contributory factor towards such an extraordinary development could be India's huge energy deficit coupled with its faster economic growth that may usher in a hitherto unimaginable investment scenario. No wonder that India's large PSUs have started firming up their plans in this green energy segment with enthusiasm. PSUs like Indian Oil Corporation (IOC), Oil and Natural Gas Corporation (ONGC), Bharat Petroleum Corporation Limited (BPCL), National Thermal Power Corporation (NTPC), Bharat Heavy Electricals Limited (BHEL) etc., have all announced big ticket investments into solar energy apart from big players in the private sector. PSUs are set to play a pivotal role in the success of the JNNSM.

PSUs' participation in government bidding

Designated as the nodal agency, NTPC Vidyut Vyapar Nigam Limited (NVVN), a wholly owned subsidiary of NTPC will procure solar power from project developers under the Mission. ONGC, GAIL (India) Limited, Steel Authority of India Limited (SAIL), and IOC were among the companies which had been invited by NVVN, which acts as a trading arm of NTPC, to submit bids for developing solar projects under Phase 1 of the Mission. Competing with the public sector majors were private players like Lanco, Larson & Tubro (L&T), Punj Lloyd, Essar Power, Welspun Energy, Moser Baer, and Reliance Power. In order to avoid cartelisation, NVVN individually notified the companies that had made requests for selection (RfS) under the Mission. It has been gathered that NVVN received 418 RfS of solar projects, both PV and thermal from various developers. Of these, it has received 343 applications for solar PV and 55 for solar thermal. RfS were called for developing 150 MW of solar PV projects with a capacity of 5 MW each and 470 MW of solar thermal projects with a minimum capacity of 20 MW and maximum of 100 MW each.

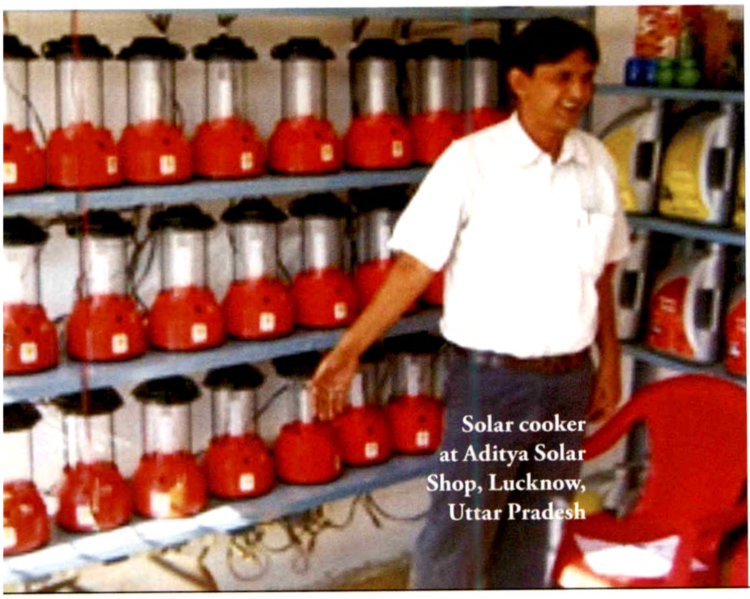
> **With the Indian government making a strong commitment towards solar energy, the PSUs have planned investments in solar energy as a part of their strategic growth mission.**

Solar plans of PSU companies

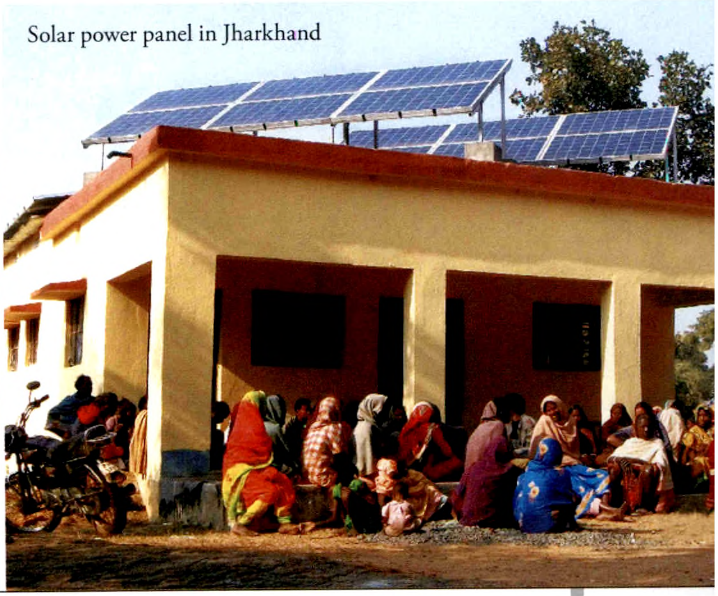
India has huge state run PSUs like NTPC, BHEL, Bharat Electronics Limited (BEL), ONGC, Oil India Limited (OIL), IOC, Hindustan Petroleum Corporation Limited (HPCL), BPCL etc. With the Indian government making a strong commitment towards solar energy, these companies have planned investments in solar energy as a part of their strategic growth mission. Details of some of the activities of selected PSUs are:

NTPC and BHEL in the lead: With a power generation capacity of around 30 GW, NTPC is India's largest power utility. It is leading the way by planning large solar capacities on its own. NTPC has decided to add around 301 MW of solar power by March 2014. The other public sector giant BHEL has strong capabilities in the field of manufacturing electricity generation and transmission equipment. Extending these capabilities in the field of solar power generation is a natural diversification by following the joint venture (JV) route with various other PSUs like HPCL, BEL and IOC to build solar equipment and power plants in the country. It is understood that BHEL has won contracts for setting up three ecofriendly grid connected solar power plants with a cumulative capacity of 6 MW on a turnkey basis for Indiabulls. These orders are a part of the JNNSM, under which the government plans to generate 20,000 MW of solar power by 2020.

BHEL is already executing a separate turnkey contract for setting up ecofriendly, grid interactive solar power plants of 3 MW capacity in Raichur district of north Karnataka



Solar cooker at Aditya Solar Shop, Lucknow, Uttar Pradesh



Solar power panel in Jharkhand

Street lighting in Uttar Pradesh

for Karnataka Power Corporation Limited (KPCL).

Indian Oil Corporation (IOC): Flagship refiner-marketer IOC is setting up a grid linked solar power plant worth about Rs 100 crore at Barmer in Rajasthan, even as the state-run firm sharpens its focus on non conventional energy sources in an attempt to supplement fossil fuels earnings with carbon credits and moves towards a green future. It has been further gathered that IOC will set up the plant as a JV with BHEL. The plant will be set up on a piece of land belonging to the oil company's marketing division, while BHEL will supply the panels and other paraphernalia. Most of the electricity generated from the plant will be sold to the general grid, while some quantity may be used for captive use. IOC already has two pilot solar charging stations commissioned in Uttar Pradesh and Orissa. IOC further plans to set up solar power panels and power plants at its over 18,100 retail outlets across the country at a cost of Rs 500 crore. IOC wants to be an aggressive participant in the JNSSM and has created a new project division called Renewable Energy and Sustainable Development. Headed by S K Sarangi, the division would take up projects on renewable energy. Modalities of such projects are being worked out at present. At its retail outlets, on the other hand, the company plans to set up solar power panels of around 30 kW each on a pilot basis to meet the power consumption needs of the outlets.

ONGC: Although, ONGC happens to be Asia's biggest oil and gas exploration company, it is also exploring avenues to wrench a share out of the solar power sector. ONGC is stated to be in touch with major foreign solar energy companies to tap the solar power sector in a big way.

BPCL: BPCL has signed a MoU with the Punjab Energy Development Agency (PEDA) to set up a power plant on a build, operate and own (BOO) basis. The plant is to be set up at Lalru in Mohali at an approximate cost of Rs 22-22.5 crore, within the next 8-10 months. BHEL and HPCL are stated to have been working out the modalities to form a new JV company with equal equity participation for setting up a series of solar PV based power plants across the country. It is understood that the modalities of the JV arrangement are being worked out to begin with the development of a 25

> **The combined efforts of the PSUs are poised to bring a win-win situation for themselves and the JNNSM to usher in an era of solar power in India in a big way.**

Parabolic solar cooker

MW capacity solar power project costing Rs 350 crore by 2012. The two companies, as is gathered, plan to scale up their solar power capacity plans to 100 MW by 2015 and to 1000 MW by 2020.

BEL: A premier electronic manufacturing company, BEL is planning a major investment in the solar energy space in a tie up with BHEL. BEL is in the process of setting up a greenfield facility to produce 2,500 tonnes of polycrystalline silicon (also known as polysilicon), the main raw material for making solar panels, at an investment of Rs 1500 crore. This translates into 250 MW of solar energy.

Summary comments

It may be seen from above that the combined efforts of the PSUs are poised to bring a win-win situation for themselves and the JNNSM to usher in an era of solar power in India in a big way. The PSUs will continue to play a pivotal role by upscaling the use of solar energy as their corporate strategic mission and social responsibility towards sustainable development, at the same time augmenting the government's mission of climate change mitigation through achieving the Misson's targets. Focus on adhering to the target should never be altered, to ensure the steady progress towards the ultimate goals of JNNSM. ✪

The author is General Manager, Telecom, Power Grid Corporation India, New Delhi.

Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. Akshay Urja is an attempt to fulfil this need through the dissemination of 20,000 copies in India and abroad. The magazine publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photographs should be provided in high resolution files on a CD or through email. Akshay Urja will pay a suitable honorarium to the authors for each published article of 1500 words and above. The publication material in two copies, along with a soft copy on CD/ DVD/e-mail may be sent to

Editor, Akshay Urja
Ministry of
New and Renewable Energy
Block – 14, CGO Complex,
Lodhi Road, New Delhi – 110 003
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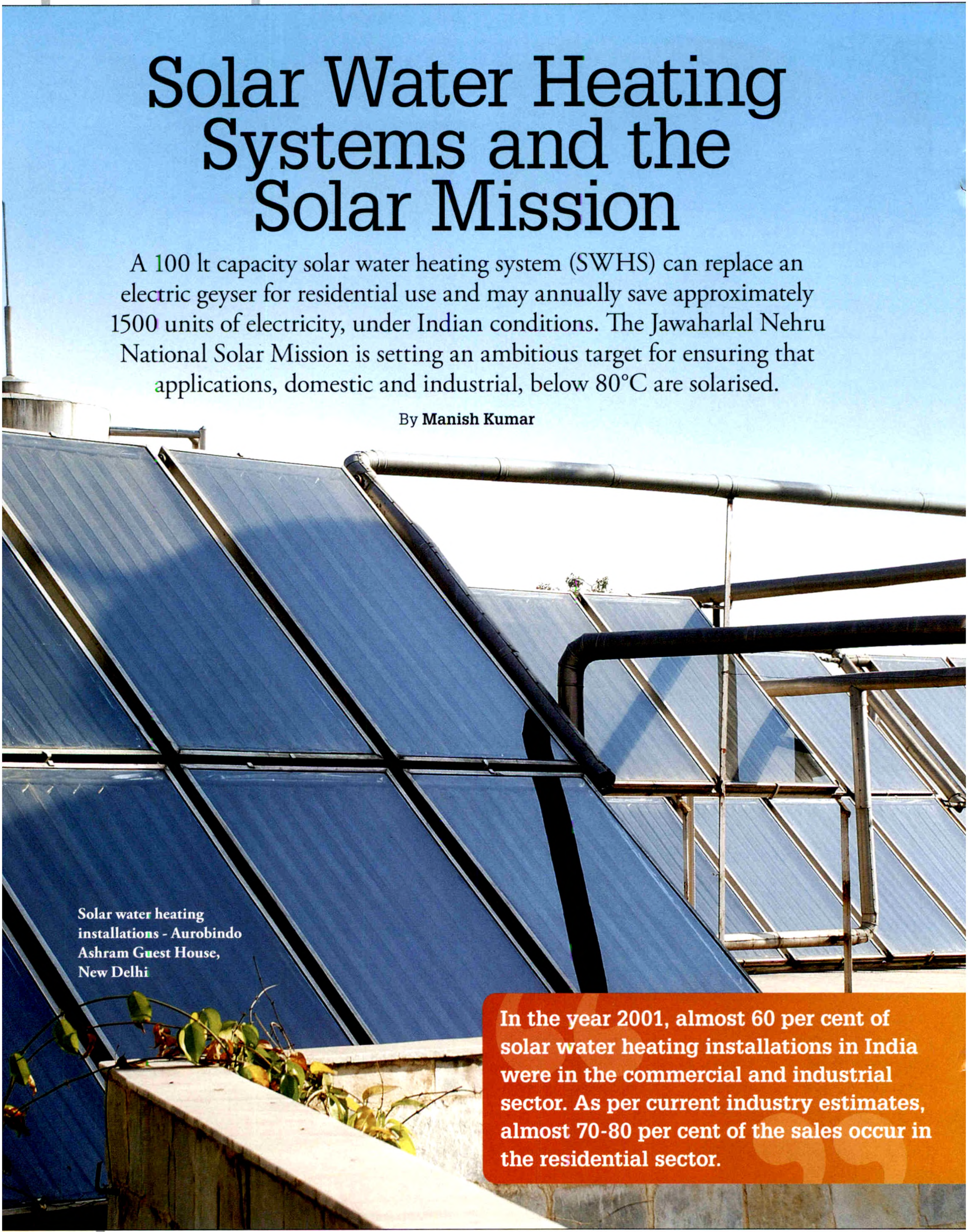
www.mnre.gov.in, E-mail aktripathi@nic.in

Solar Water Heating Systems and the Solar Mission

A 100 lt capacity solar water heating system (SWHS) can replace an electric geyser for residential use and may annually save approximately 1500 units of electricity, under Indian conditions. The Jawaharlal Nehru National Solar Mission is setting an ambitious target for ensuring that applications, domestic and industrial, below 80°C are solarised.

By **Manish Kumar**



Solar water heating installations - Aurobindo Ashram Guest House, New Delhi

> **In the year 2001, almost 60 per cent of solar water heating installations in India were in the commercial and industrial sector. As per current industry estimates, almost 70-80 per cent of the sales occur in the residential sector.**

Solar energy, being abundant and widespread in its availability, is one of the most attractive sources of energy in India. Tapping this energy will not only help in bridging the gap between demand and supply of electricity but also save money in the long run. A 100 lt capacity SWHS can replace an electric geyser for residential use and may annually save approximately 1500 units of electricity, under Indian conditions. It has also been estimated that a 100 litre per day (lpd) system (2 sq m of collector area) installed in an industry can save close to 140 lt of diesel in a year. Based on the above (100 lpd system saves 1500 units of electricity), it is estimated that in generating the same amount of electricity from a coal based power plant, 1.5 tonnes of carbon dioxide would be released into the atmosphere annually. Therefore, one million SWHS installed in homes can result in a reduction of 1.5 million tonnes of carbon dioxide emissions into the atmosphere.

SWHS and the Solar Mission

The immediate aim of the Jawaharlal Nehru National Solar Mission (JNNSM) is to focus on setting up an enabling environment for solar technology penetration in the country both at the centralised and decentralised level.

Some targets of the Solar Mission with regard to SWHS are:

- To create favourable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.
- To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022.

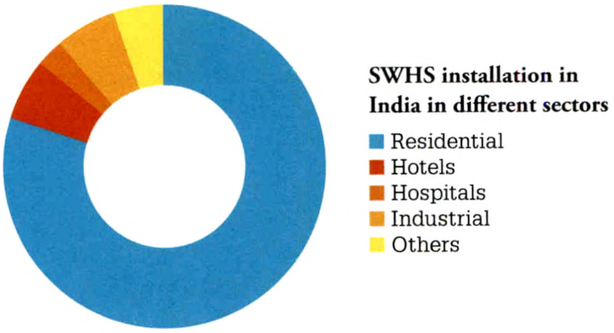
The Solar Mission in its first two phases will promote solar heating systems, which are already using proven technology and are commercially viable. It is setting an ambitious target for ensuring that applications, domestic and industrial, below 80°C are solarised. The key strategy would be to make necessary policy changes to meet this objective step wise as follows:

- Firstly, making solar heaters mandatory, through building bye laws and incorporating it in the National Building Code;
- Secondly, ensuring the introduction of effective mechanisms for certification and rating of manufacturers of solar thermal applications;
- Thirdly, facilitating measurement and promotion of these individual devices through local agencies and power utilities; and
- Fourthly, supporting the upgradation of technologies and manufacturing capacities through soft loans, to achieve higher efficiencies and further cost reduction.

In 2001, almost 60 per cent of solar water heating installations in India were in the commercial and industrial sector. As per current industry estimates, almost 70-80 per cent of the SWHS sales occur in the residential sector.

So, the residential sector has overtaken the commercial and industrial sectors and has become the main driver for growth of SWHS in India. Almost 60 per cent of these households are located in Maharashtra and Karnataka alone. More than 95 per cent of these households are located in the urban areas.

In Maharashtra, SWHS totalling a capacity of around 35 lakh lpd have been installed. Loans up to 85 per cent of the cost of a Bureau of Indian Standards (BIS) approved SWHS are available from nationalised and cooperative banks. The rate of interest for these loans is 2 per cent for individuals, 3 per cent for non profit organisations and 5 per cent for profit



SWHS installation in India in different sectors

Indian scenario of solar water heating collector area	
Techno economic potential	40 million sq m
National Solar Mission goal	20 million sq m by 2022
	7 million sq m by 2013
Demand projection	18.7 million sq m by 2022
	5.4 million sq m by 2013
Cumulative achievement	3.52 million sq m up to 31 March 2010
Preproject baseline	2.55 million sq m as on 30 September 2008

Solar water heating system at Sunbeam Hotel, Chandigarh

making organisations. The loan repayment period is 5 years - as arranged by the Ministry of New and Renewable Energy (MNRE) with the banks. The MNRE plans to include more nationalised banks for such loan facilities in the future. In Maharashtra there are eight manufacturers who have the BIS certification for solar flat plate collectors (FPCs). In addition, Indian Renewable Energy Development Agency Limited (IREDA), New Delhi, is also extending soft loans to end users under certain terms and conditions.

If a loan is not availed, then a central subsidy of Rs 2,200 per collector for non profit institutes and Rs 1650 per collector for profit making institutes is available.

In Karnataka also soft loans are available for installation of heating systems under the MNRE's SWHS scheme. The rate of interest for these loans is 2 per cent for domestic, 3 per cent for institutional and 5 per cent for commercial use.

Capital subsidy equivalent to upfront interest subsidy has been introduced to registered institutions and registered commercial establishments that do not avail soft loans. A capital subsidy of Rs 1100 per sq m of collector area will be available to registered institutions and that of Rs 825 per sq m to registered commercial establishments.

The Bangalore Mahanagara Palike vide bye law number 29 has issued an Order making the usage of solar water heaters mandatory for buildings having 200 sq m of floor area or 400 sq m of site area and 500 lpd for apartments having 5 units. To encourage the use of solar water heaters, which help in reduction of peak loads, all electricity supply companies in Karnataka are providing a rebate of 50 p per unit with a maximum limit of Rs 50 per installation. So far, around 5 lakh collectors have been installed in the State. In some states, rebates of up to Rs 100 are being provided by the government in the monthly electricity bills for 100 lpd.

Recent policy of Indian Government regarding SWHS

The MNRE has approved financing by banks for FPCs and evacuated tube collector (ETCs) based

SWHS manufactured/installed by the BIS approved manufacturers, with capital subsidy and refinance support from the National Bank for Agriculture and Rural Development (NABARD).

Capital subsidy and refinance would be made available from time to time as per the specifications of MNRE/IREDA. For ETCs based SWHS, capital subsidy will be limited to Rs 3,000 per sq m of collector area while for FPCs with liquid as the working fluid, the subsidy will be limited to Rs 3,300 per sq m. For FPCs with air as the working fluid, the capital subsidy is limited to Rs 2,400 per sq m of collector area.

The eligible capital subsidy would be released upfront to the banks on receipt of the drawal application format after sanction of the loan by the bank. However, from the financing banks the capital subsidy component would be released to the suppliers on behalf of the borrower only after satisfactory installation and commissioning of the system. Though, in order to enable the borrowers to access the benefit of the capital subsidy, the loan repayment period would have a minimum lock-in period of three years from the date of disbursement of the first instalment of the loan.

The borrowers are required to bring in 20 per cent of the cost of the project as the margin money for accessing credit facilities from banks to acquire the assets. The loans to cover the balance after reducing the eligible capital subsidy, would be extended with a repayment period not exceeding 5 years and would carry an interest rate of 5 per cent per annum. No interest will, however, be charged by the financing banks on the capital subsidy component.

The attractiveness of SWHS

It makes economic sense to think beyond the initial purchase price and consider the lifetime energy costs. One would spend much more on electricity over an electric geyser's lifetime when compared to the initial price of a SWHS and its maintenance over its expected lifetime of 15-20 years. Thus the overall cost of SWHS from cradle to grave would be a small fraction compared to that of an electric geyser, not to mention the invaluable environmental benefits of a SWHS.

However, immense care should be taken in choosing a solar water heater, just as one would in the purchase of any major appliance. A solar water heater is a long term investment that will save money and energy for many years. Like other renewable energy systems, solar water heaters minimise the environmental impact yet allow one to enjoy a comfortable, modern lifestyle. In addition, they provide insurance against energy price increase, help reduce dependence on imported oil, and are investments in everyone's future.

A solar water heater is a long term investment that will save money and energy for many years.

The use of 1000 SWHSs of 100 lt capacity (2,000 sq m of collector area) each can contribute to a peak load shaving of 1 MW. Also, a SWHS of 100 lt capacity can prevent emission of 1.5 tonnes of carbon dioxide per year.

The challenges and way forward

The main challenges for achieving a 15 per cent compound annual growth rate (CAGR) in SWHS collector area from now up to the targeted values in 2022 are:

- Market barriers concerning high initial cost of the SWHS and inefficient supply chain from manufacturing to installation at customer's premises, which thwarts adoption of SWHS even when the scheme is supported by soft loans, capital subsidies and electricity rebates.
- Technological barriers concerning higher efficiency SWHS in which the issues of space constraint, maintenance and quality of components are overcome by enabling more energy conversion per unit area of solar collector.
- Administrative barriers like lack of enforcement and monitoring of relevant building bye laws wherever existing and lack of one stop solutions for SWHS, which result in good policies not producing desired results.
- Lack of enabling mechanisms such as markets offering customised solutions for dwelling/institutional/commercial units like multistoried apartments/business process outsourcing units (BPOs)/food courts etc.
- Inadequate mass awareness programmes.

In economic parlance, solar energy and electricity, and extending the relationship further, solar energy based products and electricity based products should be perfect substitutes. When the price of electricity goes up, the demand for solar energy should also go up. The price of grid connected and off grid electricity is going up but it is not translating into increased demand for SWHS. Therefore, polices should be geared towards removing barriers and pushing SWHS to a considerable set of energy consumers so that the tangible and intangible benefits of SWHS can accrue to individuals and the nation. ✪

The author is Joint Director and Energy-Auditor, Petroleum Conservation Research Association, New Delhi

Web/Book Alert

Website

Getting the REC

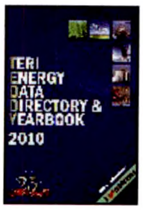
www.recregistryindia.in

The web site, launched on 18 November 2010 provides a step by step guide to Renewable Energy Certificates (REC). The Electricity Act, 2003, the policies framed under the Act, as also the National Action Plan on Climate Change (NAPCC) provide for a roadmap for increasing the share of renewables in the total generation capacity in the country. It is in this context that REC assumes significance. This concept seeks to address the mismatch between availability of RE sources and the requirement of the obligated entities to meet their renewable purchase obligation. Central Electricity Regulatory Commission (CERC) has notified regulation on REC in fulfilment of its mandate to promote renewable sources of energy and development of the market in electricity. The framework of REC is expected to give a push to RE capacity addition in the country.

Financing RE

www.indiamicrofinance.com

The website publishes specialised news and information on the emerging microfinance sector with an emphasis on developments in the Indian economy especially with regard to investments in the renewable sector. Indiamicrofinance.com seeks to highlight success stories and interviews on microfinance with the goal of encouraging a rational growth of the industry. It also provides reports and statistics on emerging opportunities in the Indian economy.



TERI Energy Data Directory (TEDDY) 2010

Author: TERI
Hardcover: 464 pages
Cover price: USD 129 (Year: 2011)
ISBN: 9788179933930

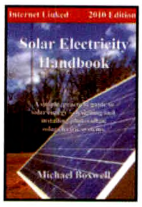
Migration and Remittances Factbook 2011

by **World Bank**
Paperback: 256 pages
Cover price: USD 39.95
Publisher: World Bank (November 2010)
ISBN: 978-0-8213-8218-9

Mainstreaming Building Energy Efficiency Codes in Developing Countries

Global Experiences and Lessons from Early Adopters

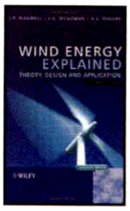
by **Feng Liu, Anke S Meyer, John F Hogan**
Paperback: 224 pages
Cover price: USD 25
Publisher: World Bank (October 2010)
ISBN: 978-0-8213-8534-0



2011 Solar Electricity Handbook

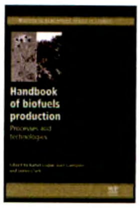
A simple, practical guide to solar energy - designing and installing photovoltaic solar electric systems.

by **Michael Boxwell**
Paperback: 187 pages
USD 14.99
Publisher: Greenstream Publishing (February 2011)
ISBN: 978-1-907670-04-6



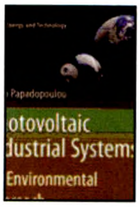
Wind Energy Explained: Theory, Design And Application, 2nd Edition

by **James F Manwell, Jon G McGowan, Anthony L Rogers**
Hardcover: 704 pages
Cover price: USD 100
Publisher: John Wiley and Sons (February 2010)
ISBN: 978-0-470-01500-1



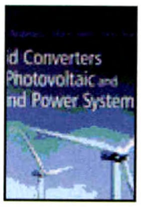
Handbook of Biofuels Production: Processes and Technologies

Edited by **R Luque, J Campelo, J Clark**
Hardback: 688 pages
Cover price: USD 280
Publisher: Woodhead Publishing Limited (November 2010)
ISBN 1 84569 679 4
ISBN-13: 978 1 84569 679 5



Photovoltaic Industrial Systems An Environmental Approach

by **Elena Papadopoulou**
Hardcover: 130 pages
Cover price: 99.95 EURO
Publisher: Springer (2011)
ISBN: 978-3-642-16300-5



Grid Converters for Photovoltaic and Wind Power Systems

by **Remus Teodorescu, Marco Liserre, Pedro Rodriguez**
Hardcover: 416 pages
Cover price: USD 160
Publisher: Wiley (March 2011)
ISBN: 978-0-470-05751-3

Inputs from : various websites

National

1 to 2 March 2011	International Symposium on Energy Materials: Opportunities and Challenges (ISEM-2011) Place: Kolkata Organised by: Central Glass and Ceramic Research Institute (CGCRI) Contact: 91 (33) 2473 5829 Website: www.cgcri.res.in
10 to 11 March 2011	RenewCon Solar India 2011 Place: Mumbai Organised by: The Energy Business Conferences Contact: 91 (22) 4046 1466 Website: www.renewconsolar-india.com
18 March 2011	National Conference on Electrical Systems and Renewable Energy 2011 (NESR'11) Place: Tiruchirappalli Organised by: Department of Electrical and Electronics Engineering, Anna University of Technology, Tiruchirappalli Contact: 91 (431) 240 7970 Website: www.tau.edu.in
25 March 2011	National Workshop on Solar Photovoltaic Component, System and Design Place: Noida Organised by: ITS Engineering College, Greater Noida Contact: 91 (120) 233 1000, 91 (0) 991 096 2760 Website: www.itsecgn.edu.in
21 to 23 April 2011	World Renewable Energy Technology Congress & Expo'2011 Place: New Delhi Organised by: World Renewable Energy Technology Congress & Expo'2011 Contact: 91 (11) 2453 8318 Website: www.wretc.in

International

02 to 04 March 2011	World Sustainable Energy Days 2011 Place: Wels, Austria Organised by: OO Energiesparverband Contact: 43 (732) 77201 4380 Website: www.wsed.at
07 to 08 March 2011	Renewable Energy Development on Federal Lands Place: San Diego, California Organised by: Electric Utility Consultants, Inc. Contact: 11 (303) 770 8800 Website: www.euci.com
15 to 16 March 2011	Biomass Conference 2011 Place: Kuala Lumpur Malaysia Organised by: Asia Executive Programs Sdn Bhd Contact: 60 (3) 6203 2009 Website: www.aep.com.my
21 to 24 March 2011	Solar Power Finance and Investment Summit 2011 Place: San Diego, California Organised by: Information Forecast Inc. Contact: 11 (818) 888 4444 Website: www.infocastinc.com
23 to 24 March 2011	Offshore Wind Power Development Asia 2011 Place: Shanghai, China Organised by: EnergyIQ, International Quality & Productivity Centre Contact: 65 6722 9388 Website: www.iqpc.com
24 to 25 March 2011	Renewable Energy and Grid Integration China Summit 2011 Place: Beijing, China Organised by: The Oppland Corporation Contact: 86 (21) 5058 9600 Website: www.opplandcorp.com
25 to 27 March 2011	2011 International Conference on Future Environment and Energy (ICFEE 2011) Place: Sanya, China Organised by: Asia-Pacific Chemical, Biological & Environmental Engineering Society (APCBEES) Contact: 852 3069 7153 Website: www.icfee.org
31 March to 2 April 2011	Sustainable Environment Technologies-SET2011 Place: Los Angeles, California Organised by: Sustainable Environment Technologies Contact: 11 (213) 483 8182 Website: http://sustainableindustries.com

Renewable Energy at a Glance

Cumulative deployment under various renewable energy schemes/programmes in India

Renewable energy Programmes/systems	Cumulative achievements (as on 31 December 2010)
1. Power from renewables	
A. Grid interactive renewable power	**In MW**
Wind power	13065.78
Small hydro power	2850.25
Biomass power (agro-wastes/residues)	979.10
Bagasse cogeneration	1494.53
Waste to power	72.46
Solar power	17.82
Sub total (A)	**18479.94**
B. Off grid/distributed renewable power(including captive/CHP plants)	
Biomass power/Cogeneration (Non-Bagasse)	267.08
Biomass gasifiers	128.16
U&I waste-to-energy	60.78
Rural waste-to-energy	0.45
Solar PV power plants and street lights(>1kW)	2.39
Aero-generators/hybrid systems	1.07
Sub total (B)	**459.93**
Total (A+B)	**18939.87**
2. Remote Village Electrification (villages/hamlets provided with electricity/lighting systems)	**6446/1587**
3. Decentralised energy systems	
Family type biogas plants (in lakh)	43.10
SPV street lighting system (in nos.)	1,22,339
SPV home lighting system (in nos.)	6,69,400
SPV lanterns (in nos.)	8,13,380
SPV pumps (in nos.)	7495
SPV water heating-collector area (in million sq m)	3.53
Solar cookers (in lakh)	6.64
Wind pumps (in nos.)	1420

MW = Megawatt; Sq m = Square metre

Higher Courses in RE

Growing energy demand especially in renewables, coupled with specialised manpower can achieve energy security for India. Here is a list of universities that offer special courses on energy studies including renewables. Check it out!

www.pdpu.ac.in

School of Solar Energy, Pandit Deendayal Petroleum University, Gujarat
Degree: MTech; PhD in thrust areas of solar energy technologies
Course: Energy Systems & Technology

www.annamalaiuniversity.ac.in

Directorate of Distance Education, Annamalai University, Chennai
Degree: PG Diploma
Course: Electrical Energy Management and Energy Audit

www.uniraj.ac.in

Centre for Non Conventional Energy Resources, University of Rajasthan, Jaipur
Degree: MPhil; PhD in Solar Energy: Materials and devices
Course: Energy

www.nitc.ac.in

Mechanical Engineering Department, National Institute of Technology Calicut
Degree: MTech
Course: Energy Engineering; Thermal Sciences

http://rgpv.ac.in

School of Energy Technology, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal
Degree: MTech
Course: Energy and Environment Management; Energy Technology

www.manit.ac.in

Department of Energy, Maulana Azad National Institute of Technology, Bhopal
Degree: BTech, MTech
Course: Energy; Energy Engineering

www.vit.ac.in

School of Mechanical and Building Sciences, VIT University, Vellore
Degree: MTech
Course: Energy & Environmental Engineering

www.lkouniv.ac.in

Department of Physics, University of Lucknow, Lucknow
Degree: MSc
Course: Renewable Energy

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For more information, please contact:

Hitesh Jain T:: 91.9717488144 / E:: Hitesh.Jain@in.ul.com
UL India Pvt Ltd T:: 91.80.41384500 / E:: Customerservice.in@in.ul.com

Volume 4 ■ Issue 4 ■ February 2011

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Renewable Energy Akshay Urja

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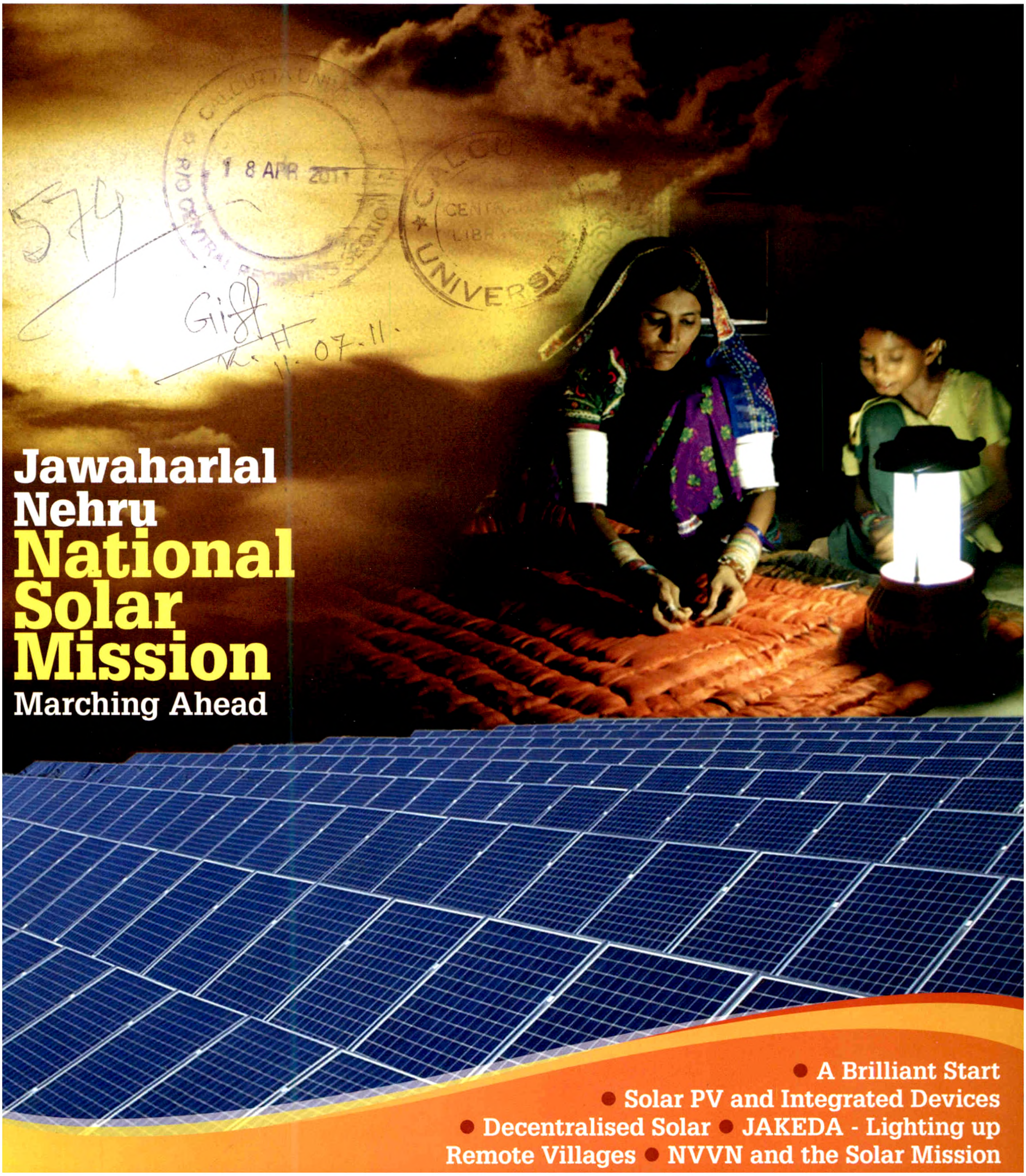

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Jawaharlal Nehru National Solar Mission

Marching Ahead

- A Brilliant Start
- Solar PV and Integrated Devices
- Decentralised Solar
- JAKEDA - Lighting up Remote Villages
- NVVN and the Solar Mission

WORLD
RENEWABLE ENERGY
TECHNOLOGY CONGRESS

21st - 23rd April 2011, Le Meridien New Delhi

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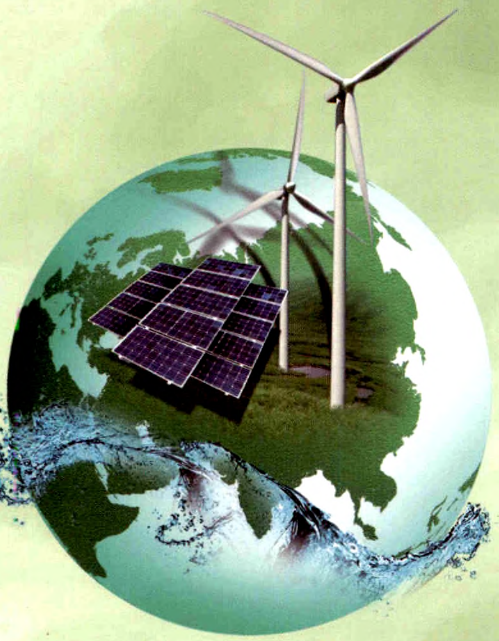

Come & be a part of a Renewable Energy Future

THE CONFERENCE

- An agenda is set for 3 days conference to share your experiences, deliberate today' status and **formulate vision for the sustainable development** of renewable energy, its technology and future in India.
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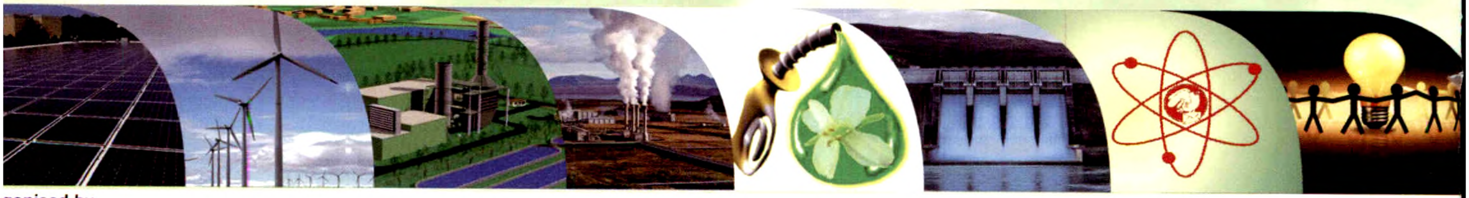

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21st - 23rd April, 2011 Le Meridien New Delhi India

Renewable Energy
Akshay Urja

Volume 4 ▪ Issue 4
February 2011

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India
(Published in English and Hindi)

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Produced by
Iris Publication Pvt. Ltd.
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Publisher and Printer
Ministry of New and Renewable Energy, New Delhi

Cover Photo: Solar home lighting system making life easier for women.

Disclaimer: The views expressed by authors including those of the editor in this newsletter are not necessarily

From the
Editor's Desk

Dear Readers,

It has been a year since the ambitious Jawaharlal Nehru National Solar Mission (JNNSM) was launched in January 2010 by the Government of India. Although the completion year of JNNSM is 2022 and a lot remains to be achieved, yet the past year with significant milestones warrants a succinct discussion.

The year 2010 also saw the release of two important JNNSM guideline documents by the Ministry of New and Renewable Energy (MNRE). The first, on 16 June 2010 was the release of the 'JNNSM Guidelines for off grid and decentralised solar applications and rooftop and other small solar power plants'. While the second was the release of the 'JNSSM Guidelines for selection of new grid connected solar power projects' document on 25 July 2010. These documents provided the impetus for the implementation of the National Solar Mission (NSM) in India .

With the basics in place it is now time to assess how the other pieces are fitting in - this issue is an introspection of the steps and efforts that are being undertaken by individuals, private organisations, the state and central government agencies et al, to make 'solar India' shine.

This issue of Akshay Urja will also update you on the progress so far of the JNNSM. It highlights the role of the NTPC Vidyut Vyapar Nigam Limited (NVVN) and the public sector undertakings (PSUs) in taking the JNNSM forward. Readers will also find articles on innovations in renewable energy as well as how the actual schemes under JNNSM are being implemented.

I hope you will find this issue interesting and informative. I invite all stakeholders and beneficiaries to share their views and experiences with us to help us expand the scope and reach of Akhay Urja.

As we leave behind the chill of winter we hope that the warm sun will usher in light into our lives and bring a smile to every face.

अक्षय ऊर्जा से देश विकास

ARUN K TRIPATHI
<aktripathi@nic.in>

Published, printed and edited for and on behalf of the Ministry of New and Renewable Energy, Government of India, from B-14, CGO Complex, Lodhi Road, New Delhi, by Dr Arun Kumar Tripathi. Printed at Aravali Printers & Publishers (P) Ltd. W-30, Okhla Industrial Area, Phase II, New Delhi - 110 020, India

Letters to the Editor

We have established a club called the Kalpana Chawla Science Club (KCSC). The club has a library with different science magazines. We came across Akshay Urja brought out by MNRE and feel that it can greatly help us in our club activities such as making technical models and projects related to renewable energy. We therefore request you to kindly send us the newsletter for our club library.

Varsh Wadhwani,
Secretary, KCSC,
Dhamtari, Chhattisgarh

Some students in our department are working on the topic 'Structural design of multistorey buildings' for a project. We would appreciate if you can publish some articles on 'energy efficient building' in your newsletter Akshay Urja.

Dr S S Quadri,
Hubli, Karnataka

My friends and I have learnt a lot from Akshay Urja. We find the newsletter very interesting and informative and we would all like to receive it.

Nitesh Bhardwaj
Jhansi, Uttar Pradesh

Congratulations for your efforts for bringing out Akshay Urja newsletter Volume 4, Issue 2 & 3.

Sandeep Garg,
Energy Economist,
BEE, New Delhi

I have been reading Akshay Urja and have found it very enriching and interesting. The articles cover a wide spectrum and are very informative. I hope you continue to do the great job.

Prof Harsh Vardhan
Associate Professor,
IILM, Gurgaon

I really appreciate the Akshay Urja newsletter because it enhances my interest in studying more about new, renewable and alternate energy as well as energy efficiency. It helps me keep up with new information about our fast changing world, particularly knowledge about recent developments in the field of energy sources that are non carbon based. Please keep exploring innovative areas of research and keep up the good work.

Muktikam Phukan,
Joint Director (FA), PCRA
New Delhi

Thank you very much for this nice newsletter, Akshay Urja, Vol 4, No 2 & 3.

P K Sundaram,
Senior Research Fellow,
Indian Pugwash Society, New Delhi

The staff and students of Parthivi College Engineering and Management (PCEM) would like to subscribe to the Akshay Urja newsletter. We feel it will be an asset to our library.

Principal,
PCEM, Sirsakala, Bhilai

I am very impressed after reading the Akshay Urja newsletter. I would like to get it regularly and would like to know about the formalities to subscribe to it.

Aravind N Mahale,
Kanara Electrical Traders,
Honnavar, Kanataka

एमएनआरई, भारत सरकार द्वारा अक्षय ऊर्जा पर आधारित तथा आप द्वारा प्रकाशित मैगजीन बहुत अच्छी लगी। समय–समय पर वैकल्पिक ऊर्जा स्रोतो के बारे में नवीन जानकारी प्राप्त होती है तथा जनता में इस मैगजीन द्वारा यह संदेश जाता है कि आधिक से अधिक नवीन ऊर्जा का प्रयोग किया जाय तथा पारंपरिक ऊर्जा को संरक्षित किया जाय जिससे पारंपारिक ऊर्जा का उपयोग अधिक दिनों तक हो सके। मैं भी आपके पत्रिका से यह सन्देश देना चाहता हूँ कि भारत की जनता अधिक से अधिक नवीन एव्म नवीकरणीय ऊर्जा का प्रयोग करें तथा सरकार के प्रयत्न में सहयोग दे। तथा घरेलू उपयोग के साथ–साथ इसका व्यापारिक उपयोग सभी प्रतिष्ठानों में किया जाय नर्सिगं होम, होटल, गेस्ट हाऊस, फैक्ट्री, राइस मिल्स, कोल्ड स्टोरेज आदि में नवीकरणीय ऊर्जा का अधिक प्रयोग किया जाना चाहिए। आपसे अनुरोध है कि उक्त पत्रिका मेरे पते पर भिजवानें का कष्ट करें।

एस एम ए जिनी,
इलाहाबाद, उत्तर प्रदेश

अरविन्द महिला विकास क्लब समिति महिलाओं पर आधारित हैं तथा ग्रामीण क्षेत्र में कार्य कर रही है। आने वाला समय सौर ऊर्जा का है। कृपया संस्था को अक्षय ऊर्जा के नए अंक के साथ कुछ पुराने अंक भी भेजा जाए। कार्यालय के लिए 2011 का कैलेन्डर भेजने की कृपा करें।

श्रीमती अंजनी रस्तोगी, अध्यक्ष,
अरविन्द महिला विकास क्लब समिति,
मंहई चौक, बुदौन, उत्तर प्रदेश

Dear Reader, Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvement in terms of content and presentation. **Editor: Akshay Urja**

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Off grid and decentralised renewable energy applications are appropriate for a vast country like India.

The Ministry may look at addressing the gap in solar tariff in the next round of bidding.

The JNNSM in its first two phases will promote solar heating systems, which are already using proven technology.

500 MW Solar Park Opens in Gujarat

Asia's first solar power park which will generate 500 MW of solar power was inaugurated by Gujarat Chief Minister Shri Narendra Modi on 30 December 2010. Total cost amounts to Rs 10,000 crore shared among different entities. Phase I worth Rs 1287 crore is being developed by Gujarat Power Corporation Limited (GPCL) in Patan District. The World Bank has invested 1 billion USD for the project while the Planning Commission and the Asian Development Bank (ADB) have pledged substantial contributions. Once functioning, the Solar Park will generate 5,000 direct jobs locally.

Business Line, 31 December 2010

HCC Enters Renewable Energy Sector

Hindustan Construction Company (HCC), the leading engineering construction company has signed a memorandum of understanding (MoU) with the Government of Gujarat for setting up a renewable energy park in Ahmedabad District's proposed Dholera waterfront. The estimated investment is Rs 12,000 crore covering 600 acres of land and would create around 17,000 jobs. The park will offer a platform for global leaders looking to set up research, development, consultancy and manufacturing of components businesses in India in the renewable energy segments such as solar, geo-thermal, wind and biomass.

Indiaclimateportal.org, 12 January 2011

Solar Power Project Licenses up for Sale

Several companies that secured solar power projects from the government are selling the licenses at a premium to bigger firms. 80 such projects were allotted ranging from 100 kW to 2 MW in 2010. There is no bar on transferring licenses under the scheme. The incentives for the big firms paying premium include assured sales, revenues from carbon credits, tax holidays and availing of accelerated depreciation on equipment.

The Economic Times, 3 January 2011

Tata Power to Sell Solar Power to GUVNL

Tata Power signed an agreement on 22 December 2010, to sell power generated at its 25 MW solar photovoltaic project at Mithapur to Gujarat Urja Vikas Nigam Ltd (GUVNL). The plant spread across 100 acres of land along the coast line of Gujarat will be among the largest plants of its kind in the country and will be commissioned by December 2011.

The Financial Express, 23 December 2010

Reliance Power Plans to Augment Renewable Energy Production Capacity

Reliance Power plans to augment its renewable energy production to 1000 MW in 2-3 years. It has wind power generation projects in Karnataka, Tamil Nadu, Gujarat and Maharashtra - 9 MW, 18 MW, 19 MW and 48 MW respectively. Further plans are to set up a concentrated solar power plant (CSP) and a solar photovoltaic plant in Rajasthan to generate 600 MW and wind power plants in Gujarat and Karnataka to generate 400MW. NTPC is partnering Reliance Power in the solar thermal project while US based Export Import Bank is providing financial support to technology for these projects.

doing-it-green.com, 12 January 2011

BST Bags Rs 300 crore Project

BS Transcomm Ltd, a Hyderabad based solutions provider to power and telecom companies bagged a Rs 300 crore project from Rural Electrification Corporation Limited (REC) on 22 December 2010. This transmission system project is for the construction of the synchronous interconnection between the southern and western regions spanning 210 kms from Raichur to Sholapur and operation and maintenance for 35 years. The project which won a tariff based global competitive bidding will be completed by March 2014.

The Asian Age, 23 December 2010

Lanco Infra to Develop Solar Power in Rajasthan

Infrastructure and power company Lanco Infrastructure has got approval to develop a 5 MW photovoltaic (PV) project and a 100 MW solar thermal project in Rajasthan. This follows its commissioning of a 5 MW project in Gujarat where it is developing an overall capacity of 35 MW. In Rajasthan, Lanco has a target of producing 200-300 MW of solar energy in the next two years. The company has got a letter of intent (LoI) from NTPC Vidyut Vyapar Nigam, the government's designated agency for procuring solar power under the Jawaharlal Nehru National Solar Mission (JNNSM). The JNNSM has a target of producing 20,000 MW solar power by 2022. Lanco also offers engineering, procurement and construction (EPC) services to other solar power developers.

The Hindu, 21 December 2010

Powergear Foray into Renewable Energy

High voltage electricity equipment manufacturer Powergear Ltd has proposed a greenfield project with a European partner for entering the renewable energy sector. The Bangalore based company has been manufacturing bus ducts and control cubicles for the energy sector. The deal will be a Rs 150 crore project where the partner would provide technology and funding support, while Powergear will look after construction and operations.

Business Standard, 31 December 2010

BHEL in tandem with JNNSM

Public sector giant BHEL has been sanctioned three orders for setting up 2 MW solar photovoltaic power plants. The orders have been placed by Citra Real Estate and Sepset Constructions Ltd for their sites in Katol and Nagpur, Maharashtra and from Priapus Infrastructure Ltd for its site at Bareilly, Uttar Pradesh. The plants will be operationalised as per the Indian Renewable Energy Development Agency Ltd under Jawaharlal Nehru National Solar Mission (JNNSM).

Indian Express, 23 December 2010

MCD Schools to use Solar Power

In an effort to save on electricity bills, the Municipal Corporation of Delhi (MCD) has decided to use solar energy in its schools for the upcoming academic session. Provisions have been made in the budget for the next financial year to install solar panels in MCD schools. The project will cost Rs 5 crore out of which Rs 30 lakhs will be contributed by the World Bank. Electricity bills per year will reduce substantially while also minimising pollution. 10 lakh children studying in MCD schools will also gain awareness on environmental issues.

The Statesman, 3 January 2011

India Shale Gas Auction

A first shale gas auction in India will be launched by the end of 2011. The Directorate General of Hydrocarbons (DGH), India's upstream regulator, is fleshing out a new shale gas policy and identifying blocks for auction, which will be completed by April 2011. Analysts say the government needs to streamline its tax and royalty regimes if the new shale licensing round is to lure heavy investment. The government has hinted that the US will help India to prepare the necessary regulatory framework. India joined the US sponsored Shale Gas Initiative in November 2010.

Indianoilandgas.com, 10 January 2011

Maharashtra Seamless Enters into PPA with NTPC

Maharashtra Seamless Ltd announced entering into a power purchase agreement (PPA) with NTPC Vidyut Vyapar Nigam Ltd (NVVN). It is for a period of 25 years for selling electricity generated by the 5 MW capacity Solar Photovoltaic Power Project to be set up by the company in the state of Rajasthan. Maharashtra Seamless has been selected by NVVN to set up this photovoltaic power project under the Jawaharlal Nehru National Solar Mission of the Government of India.

RTT News, 13 January 2011

Repower to supply 48 Wind Turbines to Belgium

Repower Systems, a unit of wind turbine maker Suzlon Energy, has signed a contract with Belgium's C-Power for supply of 48 wind energy turbines. The turbines with capacity of 295 MW are part of phases 2 and 3 of Belgium's offshore wind farm- Thornton Bank. 24 turbines are slated for installation in phase 2 in 2012 and a further 24 turbines will be installed in 2013 as part of phase 3. Companies from Belgium, Germany, the Netherlands, France and Denmark are also involved in the project.

The Economic Times, 27 November 2010

Moser Baer Solar Farm in TN

Moser Baer Clean Energy has commissioned a 5 MW solar farm at Sivaganga, Tamil Nadu. Moser Baer Solar has provided technical expertise while the International Finance Corporation and the IDBI have contributed to project finance. The Tamil Nadu Energy Development Agency (TEDA) awarded solar farm will be connected to a 110 kVA local grid and will use amorphous silicon thin film technology, best suited to Indian conditions.

The Hindu, 21 December 2010

Solar Powered Wheelchair Sets World Record

Haidar Taleb, a 47 year old man from UAE, displayed a rare combination of human spirit and willpower when he took up a 200 mile long journey on a wheelchair that he has built for himself which runs on solar power. Afflicted with polio since the age of 4, Taleb was not discouraged from taking up this challenge on the customised solar powered wheelchair, a piece of technological innovation.

www.alternative-energy-news.info, 25 January 2011

China Rules Controlling Wind Power

Gamesa, the world's third largest wind turbine maker entered the business in 1994 and by 2005, held 35 per cent of the market in China. But in July 2005 China passed a new rule whereby wind farms' equipment purchases had to include a 70 per cent domestic manufactured content. This new directive was a violation of the World Trade Organisation (WTO)'s rules. In this way, local manufacturers acquired foreign technology and today Chinese companies control half the world market and 85 per cent local market aided by low interest loans and cheap land from government. Gamesa's share has reduced to a trickle but its overall revenues have doubled.

The Asian Age, 28 December 2011

Solar Plane is Record Breaker

The UK built solar powered plane Zephyr, has achieved an unprecedented feat of flying non stop for two weeks. This plane can track pirates, alert authorities about spread of forest fires and ensure soldier communications. It remains unaffected when fighting in hilly terrain. It beat a record set in 2001 by Northrop Grumman's Global Hawk by a factor of 11.

The Asian Age, 26 December 2011

Suzlon Energy to build 150 MW wind power projects in India

Suzlon Energy, India's largest wind turbine manufacturer has signed an agreement with Hindustan Zinc Ltd, to build and operate 150 MW of wind power projects in Karnataka, Maharashtra, Rajasthan and Tamil Nadu. The total value of the deal is worth 91 million USD including orders for Suzlon's S82-1.5MW and S88-2.1MW wind turbine models. The projects will be completed in two phases, the first 50 MW being put into operation by March 2011, and the remaining 100 MW coming on line in September 2011. Power generated by the facilities will be purchased by the respective state's distribution utilities at the prevailing feed-in-tariff under a long term power purchase agreement.

powergenworldwinde.com, 7 January 2011

Gamesa set to invest Rs 1500 crore in 3 Units

World's third largest wind turbine manufacturer Gamesa has proposed three different plants - wind blades, nacelles and wind turbine towers in India. It will also make inverters for the large solar PV industry in the nation at its upcoming facility in Chennai worth Rs 1500 crore. The initial capacity of these wind turbines will be 200 MW to be scaled up to 1000 MW in two years. The total cost for the project is expected to be 70 million Euro of which 11 million Euro has been raised from the International Finance Corporation (IFC). The wind turbines will be specifically for Indian conditions.

The Financial Express, 25 December 2010

Positive Vibes in RE

A survey published by the European Commission shows that Europeans are extremely positive about solar and wind energy. Only 4 per cent of the respondents had negative views on these energy resources while 84 per cent and 87 per cent respondents gave positive feedback on wind and solar energy, respectively. Nuclear power did not garner such high positive reactions.

Balkans Business News, 10 January 2011

World's Most Powerful Wind Turbine in Germany

Enercon has announced installation in Magdeburg, Germany of the first wind turbine of type E-126 with a capacity of 7.5 MW. It is thus the world's most powerful wind turbine. Its hub height is 135 m and it will yield electricity to supply 6,000 households.

The Financial Express, 27 December 2011

African Island to Meet 25 per cent Needs from Renewables

The African island nation of Cape Verde is set to meet a quarter of its energy requirement through renewable sources. By 2012, a 28 MW Cabeolica wind facility would be operational. The European Investment Bank has provided a loan of 45 million Euro to meet the initial investment needs.

Financial Express, 27 December 2010

Los Angeles Meets Renewable Energy Goal

Los Angeles has met its goal of providing 20 per cent of the city's power from renewable sources in 2010 largely due to a wind plant. Mayor Antonio Villaraigosa set the energy goal, which was achieved by opening the municipally owned Pine Tree Wind Power Plant in the Tehachapi Mountains.

The Associated Press, 14 January 2011

Forecasting Wind Data with Cell Phone Towers

Wind data provider Onesemble has developed sensors which can keep note of wind data for around 95 per cent of the wind farms existing in the Texas area. The help of cell phone towers is sought for this purpose. Onesemble Network Sensors collect accurate data by getting to know the wind speed at a great height. This is done by placing the sensor at the height of the turbine rotor or the blades. Onesemble Network Sensors assemble figures on wind speed, direction and temperature in a cell phone tower, which are then analysed on a computer to point out what is going to happen in times to come. Data is supplied through a network of 100 sensor centres. Forecasting can be enabled every 10 minutes with the help of real time data from the sensors fed into its system. The data fed and the predictions that are attained this way are both quite precise.

alternate-energy-news.info, 30 November 2010

World's Fastest Solar Car

Australian students have designed a solar car which travels at speeds of 88 kmph, thus breaking the Guinness World Record for solar car speed previously set at 79 kmph. The Sunswift Ivy uses cells to charge a 25 kg battery and produces about 1200 watts of power. Clear sunshine is enough to run the car at record speeds.

The Times of India, 13 January 2011

marching ahead...

Jawaharlal Nehru National Solar Mission

On 11 January 2010 India launched the Jawaharlal Nehru National Solar Mission (JNNSM), for development and deployment of solar energy technologies in the country. The immediate aim of the Solar Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralised and decentralised level.

By **Staff Reporter**

India is a party to the United Nations Framework Convention on Climate Change (UNFCCC), which sets an overall framework for intergovernmental efforts to tackle challenges posed by climate change. India has reasons to be concerned about the impact of climate change since a large part of its population depends on climate sensitive sectors like agriculture and forestry for their livelihood. Any adverse impact on water availability would threaten food security and also affect the achievement of vital national developmental goals.

Planning in India seeks to increase wealth and human welfare, while simultaneously conserving the environment.

Emphasising on this aspect, the Prime Minister, Dr Manmohan Singh said, "I believe that ecologically sustainable development need not be in contradiction to achieving our growth objectives."

A range of policies and programmes have been initiated to address the problem of climate change in the context of sustainable development - promoting renewable energy is one of them. India is witnessing rapid economic growth and consequently resource demand has increased manifold, particularly for energy.

The Solar Mission and Climate Change

In the build up to the 2009 Copenhagen conference, the Bali Action Plan (BAP) was adopted in the UNFCCC in December 2007. One of the main pillars of the BAP was the Nationally Appropriate Migration Actions (NAMAs) - which are voluntary actions to be taken up by developing countries for reduction in green house gases (GHGs) and towards mitigation of climate change, according to their individual national circumstances, capabilities and resources. In India the NAMAs laid the foundation for the formulation of the National Action Plan for Climate Change (NAPCC), which was released by the Prime Minister, Dr Manmohan Singh on 30 June 2008. The NAPCC outlines a national strategy that aims to enable the country to adapt to climate change and enhance the ecological sustainability of India's development path.

Eight national missions form the core of the NAPCC, representing multi-pronged, long term and integrated strategies for achieving key goals in the context of climate change. These missions are: National Solar Mission; National Mission on Enhanced Energy Efficiency; National Mission on Sustainable Habitat; National Water Mission; National Mission for Sustaining the Himalayan Ecosystem; National Mission for a Green India; National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change.

Consequent to the announcement of the NAPCC, the Ministry of New and Renewable Energy (MNRE), Government of India, on 11 January 2010 launched the Jawaharlal Nehru National Solar Mission (JNNSM), for development and deployment of solar energy technologies in the country to achieve parity with grid power tariff by 2022.

The Solar Mission and Energy Security

The Integrated Energy Policy 2006 emphasises on ensuring energy security. It broadly aims at establishing the continuous availability of commercial energy at competitive prices to support economic growth and meet the energy needs of households with safe, clean and convenient forms of energy. The policy recognises the importance of renewable energy from a long term perspective keeping in mind the need to maximally develop domestic supply options as well as the need to diversify energy sources. NAPCC reinstates the importance of renewable energy, especially solar energy as it points out: "India is a tropical country, where sunshine is available for longer hours per day and in great intensity. Solar energy, therefore, has great potential as a future energy source. It also has the advantage of permitting decentralised distribution of energy, thereby empowering people at the grass root level". Based on this vision the JNNSM was launched.

> **"I believe that ecologically sustainable development need not be in contradiction to achieving our growth objectives."**
> **-Dr Manmohan Singh.**

Beneficiary of solar a lantern

COURTESY: BAL RASHMI SOCIETY JAIPUR

10 mw solar thermal power plant setup by ACME near Bikaner, Rajasthan

Timeline

The JNNSM adopts a three phase approach. Spanning the remaining period of the 11th Plan and the first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3.

Objectives and Proposed Roadmap

The objective of the JNNSM is to establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible.

The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralised and a decentralised level. Phase 1 will focus on capturing the low hanging options in solar thermal and promoting off grid systems to serve populations without access to commercial energy and a modest capacity addition in grid based systems. The greatest potential area of off grid relates to solar technologies. These include solar water heating systems, home lighting systems comprising of solar lanterns, solar cooking systems, solar pumps and small power generating systems. Under the Solar Mission, it has been proposed to cover 2000 MW equivalent by 2022 which includes all of the above, except solar water heating systems for which there is a separate target of 20 million sq m. Within the off grid component, there is a separate target of covering 20 million rural households with solar lights. This includes coverage under the Remote Village Electrification Programme (RVEP) wherein solar lighting is provided largely to off grid villages and is almost entirely funded by central grants. In addition, in other areas, where grid is available but power supply is erratic, solar lighting is financed through loans given by rural banks.

In Phase 2, after taking into account the experience of the initial years, capacity will be aggressively ramped up to create conditions for upscaled and competitive solar energy penetration in the country. The proposed road map for attainment entails large scale deployment of grid connected as well as distributed solar generated power, and also decentralised off grid provision for commercial energy services. The deployment across the application segments as envisaged is given in Table 1.

Phase 1 target (up to March 2013)

- Government has approved the implementation of Phase 1 of the Mission and the target is to set up 1000 MW grid connected (33 KV and above) solar power plants through NTPC Vidyut Vyapar Nigam (NVVN), a trading subsidiary of National Thermal Power Corporation (NTPC) Limited. NVVN will directly purchase the solar power from the project developers as per the norms and guidelines fixed in this regard.
- The Mission will encourage 100 MW rooftop solar photovoltaic (PV) and other small solar power plants, connected to LT/11 KV grid, to replace conventional power and diesel based generators. It is envisaged that the distribution utility will pay the tariff determined by the State Electricity Regulatory Commission (SERC) for the metered electricity generated from such applications (whether consumed by grid connected owner of the rooftop/ground mounted installation or fed into the grid).
- Deployment of 200 MW capacity equivalent off grid solar applications of solar thermal technologies (e.g. solar water heaters, solar cooking systems, air drying, steam cooking and power generation, sterling engine etc.) and PV technologies (e.g. solar PV home lighting, police station communication and lighting, tribal habitats, small powered looms, solar inverters, solar PV pumps, powering computers in schools, small milk chilling plants, refrigeration for medicines in primary health centres; systems for powering telecom towers, etc.). In addition hybrid systems would also be supported and will be implemented through a combination of low interest loans and/or central financial assistance as per norms and guidelines fixed in this regard.

> **Phase 1 will focus on capturing the low hanging options in solar thermal; on promoting off grid systems to serve populations without access to commercial energy and modest capacity addition in grid based systems.**

- Acquiring 7 million sq m of solar thermal collector area.
- Supporting various activities as necessary in research and development, human resource development, technical assistance, training, publicity and awareness etc., for successful implementation of the Mission.

The Solar Mission's strategy in Phase 1 and 2 includes

Solar home lighting systems

Table 1: Deployment across application segments

Application Segment	Target for Phase 1 (2010-13)	Target for Phase 2 (2013-17)	Target for Phase 3 (2017-22)
Solar collectors	7 million sq m	15 million sq m	20 million sq m
Off grid solar applications	200 MW	1000 MW	2000 MW
Utility grid power, including roof top	1100 MW	4000-10000 MW	20000 MW

A telecom tower running on solar power

COURTESY: DELTA

the announcement of the broad policy framework to achieve its objectives by 2022. The Mission document states that the policy will create the necessary environment to attract industry and project developers to invest in research, domestic manufacturing and development of solar power generation and thus try to create a critical mass for the domestic solar industry. The Mission will work closely with the state governments, regulators, power utilities and local self government bodies to ensure that the activities and policy framework being laid out can be implemented effectively.

Progress so far

(I) Grid connected solar power projects

During 2010-11 the Ministry has selected grid solar power projects of 800 MW capacity for implementation and power purchase agreements (PPAs) have been signed with investors. Grid connected solar power generation is a new application in the country and so far a limited capacity has been set up. Therefore, the annual targets and the requirement of funds have been set only to gradually achieve 1100 MW capacity by March 2013. In Phase 1, this comprises of the following main components:

1000 MW capacity grid solar power plants

- 84 MW capacity, connected to 33 KV and above, grid connected solar power projects have been allocated by the NVVN under the migration scheme. NVVN has signed power sale agreements (PSAs) and PPAs with the concerned states and project developers in October 2010.
- NVVN had issued request for selection (RfS) of projects of 620 MW capacity (470 MW of solar thermal and 150 MW of PV) in August 2010.
- NVVN received 423 applications for a total of 441 projects. 363 proposals were to set up PV plants of 1815 MW (at an average of 5 MW per applicant). 78 applications were for 3311 MW capacity of solar thermal projects. In October 2010 NVVN completed the scrutiny of applications for setting up the new grid connected solar power projects. NVVN then issued request for proposal (RfP) to the selected applicants, who were requested to submit their offer of discount on the Central Electricity Regulatory Commission (CERC) tariff by November 2010 for final selection of projects.

100 MW capacity solar power plants

- Projects to set up 100 MW capacity (connected to grid below 33 KV and of 100 kW to 2 MW size) have been short listed by Indian Renewable Energy Development Agency Ltd. (IREDA). All the project developers have already signed PPAs with the concerned state level utility.

Eight grid connected solar PV power projects of about 15 MW capacity have been installed in the country during the last one year. This is a satisfactory beginning considering that small capacity projects of only about 2.1 MW were installed before this.

(II) Off grid solar power projects

Approximately 33 MW capacity off grid solar power projects have been sanctioned as on 10 January 2011, against a target of 32 MW for 2010-11 (Table 2). The sanctioned systems include solar power plants, street lighting systems, home lighting systems and solar lanterns for installation at

Community power plant at Rampura

police stations, hospitals, bank branches, telecom towers, bus stations, educational institutions, para military forces and border villages with scheduled caste population etc. A budget of Rs 224 crore was earmarked for the programme in the year 2010-11. The entire allocated amount was spent by December 2010.

Home lighting systems

During March to December 2010 the Ministry has electrified 300 villages and sanctioned 341 projects for electrification. Households in about 7,000 remote villages and hamlets have so far been provided home lighting systems under this programme. The sanctioned systems include solar power plants, street lighting systems, home lighting systems and lanterns. One of the major initiatives among these is to provide solar PV systems of 10.28 MW capacity to all 9,168 Panchayat buildings in Rajasthan and 1.7 MW capacity solar PV power plants for tribal hostels, police stations and forest check posts in Madhya Pradesh.

Solar thermal water heaters

The Ministry under the Solar Mission has sanctioned support for solar thermal water heating systems to Haryana Renewable Energy Development Agency (HAREDA) and Non Conventional Energy Development Corporation of Andhra Pradesh (NEDCAP). Recently, the Ministry has sanctioned capital subsidy for installations of solar thermal systems to some state government agencies including the AP Rajiv Swagruha Corporation in Andhra Pradesh and Shri Mata Vaishno Devi Shrine Board in Jammu and Kashmir. Subsidies are made available to the state agencies, which can be transferred to end users at the time of installation of the solar powered systems. At present a capacity of 60,000 sq m has already been sanctioned to the states and several state agencies are coming forward for installation of solar thermal systems.

Stand alone rural solar plants

Working towards its commitment to set up stand alone rural solar plants in the special category states and remote and difficult regions including border areas, the Ministry has sanctioned projects to set up power plants in Lakshadweep, Arunachal Pradesh, Jammu and Kashmir, Punjab (Gurdaspur), Sikkim, Uttarakhand etc., as on 7 January 2011.

(III) Financial assistance and soft loans

The Ministry is promoting lighting and hot water systems through the National Bank for Agriculture and Rural Development (NABARD) across the country. Under this

> **The Mission will work closely with the state governments, regulators, power utilities and local self government bodies to ensure that the activities and policy framework being laid out can be implemented effectively.**

Table 2. List of projects sanctioned under off grid solar applications of JNNSM as on 10 January 2011

State	Sanctioned systems	Location	Capacity (kW)
Andhra Pradesh	Power plants and street lights	Educational institutes, MPDO offices, commercial organisations, telecom towers, theatres, NGOs, homes, art galleries, engineering colleges and tribal villages	1681
Arunachal Pradesh	Power plants	SSB Battalian HQ and border outposts	320
Assam	Power plants	Guwahati University, SSB Assam Engineering College	500
Bihar	Power plants	Telecom towers and bank branches	1022
Chhattisgarh	Power plants	Rural bank branches, hospitals, temples, Government Institutes, PWD guest houses, SBI branches, Industry/ charitable organisations	2282
Gujarat	Power plants	Saurashtra University	25
Haryana	Power plants, solar PV street lighting systems	330 villages in Sirsa, TERI retreat Gwalpahari, BPDO offices in Sirsa and Hospital at Rewari, rural branches of Banks in 13 districts	832
Himachal Pradesh	Power plants, SPV street lights, home lights, solar lanterns	SSB training centres, 34 villages in 5 districts	529
Jammu and Kashmir	Power plants, home lights, solar lanterns	Leh District, Kargil District, 69 health centres, Vaishno Devi Shrine	2829
Jharkhand	Power plants	Temples in Deogarh, BIT Deogarh, Palamu Tiger Project, Jari village	416
Karnataka	Power plants	Bus stations, KDA, 50 branches of Vikas Gramin Bank, 10 other locations	195
Kerala	Power plants	Balklava Sweets, Thodupuzha	10
Lakshadweep	Solar power plants	Islands	1100
Madhya Pradesh	Power plants, SPV street lights	Tribal hostels, police stations, forest check posts, CHCs, 438 villages	1927
Maharashtra	Solar power plants	Thane Municipal Corporation and SEEPZ SEZ	150
Manipur	SPV solar plants	Hospitals, jail and State Training Academy	100
Meghalaya	Power plants, home lights	Schools and aganwadi centres	639
Mizoram	SPV power Plants	Charitable institutions, hospitals	121
Orissa	Power plant	Secretariat	50
Punjab	SPV power plants, power plants	Educational institutions, 17 villages in Gurdaspur	505
Rajasthan	Power plants, PV pumps, home lighting system	Gram Panchayats, horticulture department, villages in 20 districts	10907
Sikkim	Power plants	Border outposts of SSB	115
Tamil Nadu	Power plants	Schools, Vaishnavi College, commercial organisations	107
Uttarakhand	SPV street lighting systems, power plants, solar lanterns	316 villages, Battalion HQ and Border Posts of SSB, 9 international border blocks, 381 villages, BEL Kotdwaar	2109
Uttar Pradesh	Power plants, street lighting systems	2,964 villages, 57 Ashram schools, 294 bank branches, 70 Baroda UP Gramin bank branches, telecom towers	3568
Others	Power plants, street lights, home lights	Bank branches, educational institutions, villages	853
		Total	**32892 kW**

Source: MNRE

programme all regional rural banks will finance solar lighting for the users by providing capital subsidy of 30 per cent and soft loans at 5 per cent interest per annum, for which the Ministry is providing the funds. Details of promotional activities and incentives provided by the Ministry for the Solar Mission are:

- Capital subsidy for select devices and systems,
- Generation based incentives for power generation from wind and solar energy,
- Interest subsidy on select renewable energy devices and power projects,
- 80 per cent accelerated depreciation during first year,
- 10 year tax holiday for power projects,
- Nil or concessional customs duty,
- Excise duty exemption on specific devices and systems,
- 5 per cent duty on solar power projects,
- Loans through IREDA,
- Preferential tariff by some of the states on renewable power,
- Publicity and awareness campaigns through print and electronic media,
- Attainment of grid parity, discounting process for identifying investors has led to 30 per cent discounts on CERC tariff.

(IV) MNRE's promotional schemes

Promotion schemes for off grid applications:

- For Solar PV power packs a 30 per cent capital subsidy and loan at 5 per cent on 50 per cent of the capital cost has been put in place. MNRE considered Rs 300 per watt (with battery) as the benchmark for extending a 30 per cent capital subsidy, which amounts to Rs 90 per watt. It is Rs 70 per watt without battery. Also, PV crystalline silicon solar cells should be used.

One of the main objectives of the Solar Mission is to globally take a leading role in manufacturing of cutting edge solar technologies.

Weaving at night with a solar lantern

- For solar thermal heaters subsidy is provided at Rs 3,000 per sq m for evacuated tube collectors (ETCs) and Rs 3,300 per sq m for flat plate collectors (FPCs).
- In respect of home lighting systems of up to 200 W lighting with 2x100AH battery set, an estimated cost of Rs 60,000 was prescribed by MNRE. The subsidy on the same is Rs 18,000 and loan amount is Rs 30,000. Inverter based systems are also eligible for financing schemes.
- To meet electricity requirements of unelectrified rural areas, a capital subsidy of up to Rs 150 per watt will be extended for mini local grids.
- Individuals are eligible up to 1 kW (5 kW for water pumping schemes) capacity and commercial/non commercial entities are eligible up to 100 kW. Micro grids of up to 250 kW capacity can be set up.
- Capital subsidy would be released to the banks upfront, on receipt of sanction of loan by the bank to the borrower. The loan amount is repayable in monthly instalments within 5 years. The banks will get refinancing of loan amount from NABARD (through IREDA) at 2 per cent.

Schemes for promotion of grid interactive renewable energy power projects:

The Ministry has been providing subsidies to various organisations for grid interactive power generation projects based on renewable energy sources. For grid connected projects of at least 100 kW and up to 2 MW, connected to HT level (below 33 kV) of distribution network, a grid based incentive is payable to the project developer. Its value is the difference between the tariff determined by the CERC (Rs 17.9 for solar PV and Rs 15.4 for solar thermal) and the base rate, which is equal to INR 5.5 per kWh for the financial year of 2010 to 2011, and escalates 3 per cent every year. In addition to various schemes, the debt portion of investment can be financed by a soft loan at 5 per cent interest rate, which can be availed from IREDA.

Solar lantern making the nights bright

(V) Accessibility

To ensure access, MNRE is promoting the home lighting and hot water systems through NABARD. All regional rural banks will provide capital subsidy and soft loans to the users for which the funds will be provided by MNRE.

(VI) Research and development

The focussed efforts of the government on research and development include:

Solar PV technology

Government efforts to support research and development in PV technology are through (i) supporting research groups and industry in reducing the cost of solar cells, modules and systems by improving the conversion efficiency, reducing the consumption of raw materials and developing new materials and processes; (ii) developing more efficient and low energy consuming loads for use with PV systems; (iii) supporting industry to indigenously produce critical materials such as silicon etc.; (iv) improving the reliability and life of PV products and systems; and (v) encouraging volume production in the country by facilitating market development including exports etc. The Ministry has identified the thrust areas of research and nine projects on different aspects of solar PV technology are under implementation.

Solar thermal

Research and development activities in the area of solar thermal energy have led to significant achievements in the improvement and commercialisation of solar water heating systems and solar cookers. The technology of solar flat plate collectors used in solar water heating systems has changed from black painted absorbers to selectively coated absorbers;

the workmanship, finishing, piping and system design have also markedly improved. A number of models of solar cookers are now available commercially. These include box type model for domestic use, dish concentrating cookers for individuals and small establishments, community (Scheffler) solar cookers for indoor cooking, and steam cooking systems for large kitchens catering to the cooking requirements of thousands of people. Research activities have also been undertaken to establish the efficacy of various concepts of solar architecture.

Cutting edge research and development

Six major research and development projects, three each in solar thermal and PV technologies have been sanctioned. Projects with strong industry interface have been encouraged.

Centres of excellence

National Centre for Photovoltaic Research and Education (NCPRE) has been set up at the Indian Institute of Technology (IIT), Mumbai. While the Amrita Centre for Nanosciences and Molecular Medicine (ACNSMM) at Cochin and the Centre for Solar Passive and Green Building at Center for Environmental Planning and Technology University (CEPT), Ahmedabad are being set up.

Supporting start ups and innovations

The Centre for Innovation Incubation and Entrepreneurship (CIIE) has been set up in collaboration with the Indian Institute of Management (IIM), Ahmedabad to promote innovation in renewable energy and to provide incubation, mentoring and financial support for aspiring entrepreneurs and innovators.

Solar Energy Centre

The Ministry has set up a Solar Energy Centre at Gwalpahari, Gurgaon. The Centre has world class facilities for testing solar thermal and solar PV devices and systems. In addition the Centre is also providing training and consultancy support to various user organisations. As a result of the efforts made by the Centre the Indian solar energy industry is able to meet various national and international standards for solar energy systems. In addition the Centre is also undertaking joint research on (i) testing and field performance evaluation of solar cells, modules and systems, (ii) development of secondary reference solar cells, (iii) development of long life batteries for solar PV systems, and (iv) development of new applications.

(VII) Developing human resources

Training

Model course content to teach solar energy at B.Tech, M.Tech and ITI levels has been prepared. Some of the National Institutes of Technology (NITs) have started following this course. In collaboration with Director General of Employment and Training, Ministry of Labour, course material for craftsmen training and modular skill development has been finalised.

Power station at Kurawa Village, Jharkhand

> **To achieve the local demand, right levels of incentives for solar generation have to be continued, with a combination of financing.**

Technicians programme

An MoU has been signed with Indira Gandhi National Open University (IGNOU) to start a technicians programme in the areas of solar PV and solar thermal from the next academic year. Course content to provide such specialised training to ITI passed technicians on PV, solar thermal energy and solar thermal power systems has been developed.

National Solar Fellow

This scheme has been developed to encourage innovative ideas in research and development and to promote research and product development in the area of solar energy.

Other human resource development (HRD) schemes

The Ministry has expanded the HRD scheme to (i) award substantially higher number of fellowships for pursuing postgraduate and doctoral programmes in the area of renewable energy (RE); (ii) provide grant for up gradation of laboratory facilities; (iii) provide support for RE chairs etc.

Way ahead

One of the main objectives of the Solar Mission is to globally take a leading role in manufacturing (across the value chain) of cutting edge solar technologies and target a 4

Table 3: List of selected projects by NTPC Vidyut Vyapar Nigam Limited (NVVN)

State	Location	Project capacity (MW)	Solar project type
Andhra Pradesh	Kutagulla, Kadiri, Anantapur	5	PV
	T Veerapuram, Ravadurg, Anantapur	5	PV
	Thummala, Amadgur, Anantapur	5	PV
	Virannapalle, Pamidi, Anantapur	50	Thermal
Gujarat	Dwarka, Mojap, Jamnagar	20	Thermal
Karnataka	Murudi, Molakalmur, Chitradurga	5	PV
	Mandva, Malavalli, Belakavadi	5	PV
Maharashtra	Kalhe	5	PV
Orissa	Khurda	5	PV
Rajasthan	Mundwa, Naguar, Naguar	5	PV
	Bhojas, Khinvsar, Nagaur	5x6 = 30	PV
	Kathali, Javal, Nagaur	5	PV
	Kantia, Nagaur	5	PV
	Bap, Phalodi, Jodhpur	5x2 =10	PV
	Amla, Phalodi, Jodhpur	5	PV
	Rawre, Phalodi, Jodhpur	5	PV
	Natisara, Phalodi, Jodhpur	5	PV
	Deh, Kolayat, Bikaner	5	PV
	Gajner, Kolayat, Bikaner	5	PV
	Ladkan, Kolayat, Bikaner	5	PV
	Marudi, Barmer	5	PV
	Pareware, Jaisalmer	5	PV
	Lanwa, Pokran, Jaisalmer	5	PV
	Nokh, Pokhran, Jaisalmer	5	PV
	Chinnu, Nachna 1, Jaisalmer	100	Thermal
	Chinnu, Nachna, Jaisalmer	100	Thermal
	Pokaran, Pokaran, Jaisalmer	100	Thermal
	Parewar, Jaisalmer	50	Thermal
	Nokh, Pokhran, Jaisalmer	50	Thermal
Tamil Nadu	Kombukaranatham, Tuticorin	5	PV
Uttar Pradesh	Naini, Allahabad	5	PV
	Total	**620 MW**	

Solar home lighting in Jhansi District, Uttar Pradesh

to 5 GW equivalent of installed capacity by 2020, including setting up of manufacturing capacities for polysilicon material to make about 2 GW capacity of solar cells annually. It is necessary to augment the indigenous capacity to manufacture silicon material by setting up more plants in the public and private sector. New facilities are being created to manufacture concentrators, collectors, receivers and other components to meet the demand for solar thermal plants. To achieve the local demand, right levels of incentives for solar generation have to be continued with a combination of financing to set up solar farms. Transparent and fast track clearances and permissions are being created in consultation with the states. The creation of land banks for solar farms has also been explored. To attain grid parity initial attractive tariff and a reduction in capital cost is necessary. The efforts from the Ministry are in the right direction to reduce the generation cost of electricity in the next 8 to 10 years through concerted research and development. In the coming 2 to 3 years the on going research efforts are expected to improve the conversion efficiency of solar cells from the existing 15-16 per cent to about 18 per cent. Further, efforts are being made by the industry to reduce the consumption of the main raw material - silicon wafers. These measures are expected to reduce the cost of crystalline silicon solar cells and modules by about 15 per cent, from the present average price of Rs 120 to Rs 100 per watt. The Ministry is already working on the following future directions:

- 50 new solar radiation monitoring stations - These new monitoring stations are being set up to provide reliable ground data for setting up solar projects.
- Doubling of solar cells capacity - Capacity of solar cells production has doubled from about 600 to 1300 MW.
- 4 test laboratories set up - These laboratories have been set up for PV module qualification testing.
- 300 MW capacity PV projects - The remaining 300 MW PV will be selected in 2011-12 for implementation. ❂

International Renewable Energy Expo and Conference - Chennai

VaVoVa 2011, an international conference cum exhibition on renewable energy was organised in Chennai from 14 - 16 of January. A workshop was organised by Tamil Nadu Energy Development Agency as a parallel event to the VaVoVa 2011.

By **Shubhra Kingdang**

A three day solar energy conference was jointly organised by the Tamil Nadu Energy Development Agency (TEDA) and Tra International Ltd. at the Mamallapuram Beach Resort and the Chennai Trade Centre, Nandampakkam, in Chennai, Tamil Nadu on 14, 15 and 16 of January 2011. The workshop was organised as a parallel event to the VaVoVa 2011, an international conference cum exhibition on renewable energy. Tamil Nadu was the first to install wind energy generators (WEG) and TEDA was the first nodal agency to be established in India for the purpose. The Ministry of New and Renewable Energy (MNRE), India has announced an ambitious four fold increase in renewable energy by 2022 to a capacity of 72.4 GW and Tamil Nadu aims to continue being in the leadership in this growth. Twenty four sessions were held in the three days and numerous topics were discussed including; Renewable Energy Certificates (REC), REC trading, Renewable Energy Regulatory Framework and Policies, Solar developers under the Jawaharlal Nehru National Solar Mission (JNNSM), Moser Baer studies, SPV cell technology and Balance of Systems. Also included was a detailed session on low and medium temperature solar collectors. In the wind energy area, sessions included discussions on increasing the wind power potential, the challenges, technology developments, certification and site identification. There were detailed sessions on various bio energies and waste to energy recovery systems. On the sidelines of the Conference a college education fair for students and a mega competition on 'Innovative ideas on Renewable Energy for college students' were also organised. The Conference was attended by scores of engineering college administrators and decision makers from all over Tamil Nadu. Over 20 country representatives participated in the event.

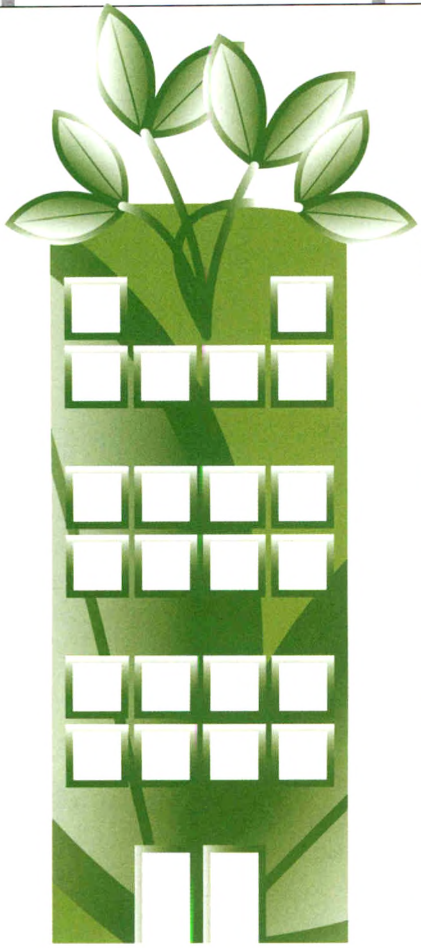
The VaVoVa 2011 was aimed at bringing together various consultants, industry experts, policy makers, vendors and manufactures along with project developers on a single platform.

NATIONAL CONFERENCE ON GREEN DESIGN: BUILDINGS AND HABITATS

The conference brought together building industry professionals from across varied disciplines.

The National Conference on Green Design: Buildings and Habitats was held on 7 and 8 January 2011 at New Delhi. It was organised by the Ministry of New and Renewable Energy (MNRE), Association for Development and Research on Sustainable Habitat (ADaRSH) and The Energy Research Institute (TERI). Speaking at the inaugural session, Dr Farooq Abdullah, Hon'ble Minister of New and Renewable Energy said, "We are greatly interested that new buildings should be energy efficient and aesthetically beautiful. While planning, regional conditions must be taken into consideration. It is vital to find out what can be done to make the process easier." During the sessions, eminent architects, government officials, construction management professionals, planners and engineers; both Indian and foreign, provided solutions for a greener future. While in his address Shri Deepak Gupta, Secretary, MNRE said, "India is already witnessing a process of rapid urbanisation. This will lead to a tremendous energy demand in urban areas. Thus keeping in mind our climatic conditions, a National rating system - the Green Rating for Integrated Habitat Assessment (GRIHA) has been developed." Following the speech, plaques were awarded to GRIHA certified projects. On the sidelines, the Conference hosted an exhibition showcasing green building products, energy efficient solutions, new technologies and services available to build a sustainable habitat. Big corporate houses and multinational companies presented their efforts in enterprise development for greener built up structures. On the second day a high level ministerial session on policy and imperatives for green building design was held, where the role of the central government in green design and green buildings was presented by Prof Saugata Roy, Hon'ble Union Minister of State for Urban Development. Dr R K Pachauri, Director General, TERI and President ADaRSH pointed out that efforts for a greener future should be taken up at the earliest as "buildings do not expand their footprints ecologically". ❂

GRIHA
teri
tional Conference on Green Design: Buildings and Habitats
7-8 Ja 2011
India Habitat New Delhi



Enabling Industry and RE dialogue

Investments in the renewable energy sector have soared with rapidly growing generating capacities as well as manufacturing capabilities.

PHD CHAMBER
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Conference on
Renewable Energy for Industry: A Parad
Chief Guest:
Hon'ble Dr. Farooq Abdullah, Minister of New & Renewable Ene
13 January 2011 New Delhi
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SUSMITA SHEKHAR

'Industry should focus on green buildings...' Shri Deepak Gupta, Secretary, MNRE

A conference on 'Renewable Energy for Industry: A Paradigm Shift' was organised by the PHD Chamber in New Delhi on 13 January 2011. Speaking at the inaugural session Shri Deepak Gupta, Secretary, Ministry of New and Renewable Energy (MNRE), said that to save power and promote renewable energy, the industry should be committed to setting up green buildings in the future; this set the theme for the subsequent proceedings of the Conference.

Shri Gupta also added that the government is ready to extend all possible help in setting up green buildings and solar installations. While the industry is aggressively involved in the development of renewable energy, particularly wind power, biomass power, bagasse cogeneration and small hydro power, some of the large industrial groups and small and medium enterprises are also entering this emerging sector.

"We need combustion based captive energy plants of 1 to 2 MW. There is a huge scope for cogeneration mode where the industry can put renewable sources of energy along with conventional sources to good and efficient use. Greater reliance on renewable energy will result in a ecologically sustainable growth. This will also reduce waste and health hazards. We need efficient waste management systems and more waste treatment plants," reiterated Shri Gupta.

He added, "Solar energy has a vast potential, but a lot needs to be done on this front. The government expects to see the deployment of 20,000 MW of solar power by 2022. The industry should install more solar heaters. Many companies are using solar heaters with good results and saving fossil fuels. MNRE is aggressively promoting rooftop solar systems and providing incentives." Investments in the renewable energy sector have soared with rapidly growing generating capacities as well as manufacturing capabilities. Venture capital and private equity investments in the sector have also been growing. Debt financing is provided by commercial banks and leading financial institutions in the power and infrastructure sectors. Indian Renewable Energy Development Agency (IREDA) the corporate financing arm of the Ministry is providing sustained financing support to the sector. ✪

What's that?

Here is an exercise that is intended to introduce you to a gamut of technical terms on solar power that can catch you unawares.

Amorphous silicon: An alloy of silica and hydrogen, with a disordered, non-crystalline internal atomic arrangement, that can be deposited in thin layers (a few micrometers in thickness) by a number of deposition methods to produce thin-film photovoltaic cells on glass, metal, or plastic substrates.

Solar Cell: A solar cell (also called photovoltaic cell) is a solid state device that converts the energy of sunlight directly into electricity by the photovoltaic effect. Assemblies of cells are used to make solar modules, also known as solar panels.

Electricity Grid: An electrical grid is an interconnected network for delivering electricity from suppliers to consumers.

Series regulator: A type of battery charge controller or regulator in which the charging current is controlled by a switch, transistor, or field-effect transistor connected in a series with the PV module or array.

Passive Solar: A system in which solar energy alone is used for the transfer of thermal energy. Pumps, blowers, or other heat transfer devices that use energy other than solar are not used.

Thermo-siphon System: Refers to the solar collector system for water heating in which circulation of the collection fluid through the storage loop is provided solely by temperature and density difference between the hot and cold fluids.

Energy Star: Energy Star is an international standard for energy efficient consumer products, which originated in the United States of America. It was first created as a US government programme during the early 1990s. Later Australia, Canada, Japan, New Zealand, Taiwan and the European Union have also adopted the programme.

Single Crystal Silicon (Czochralski): An extremely pure form of crystalline silicon produced by the Czochralski method of dipping a single crystal seed into a pool of molten silicon under high vacuum conditions and slowly withdrawing a solidifying single crystal boule rod of silicon. The boule is sawed into thin wafers and fabricated into single-crystal photovoltaic cells.

Semi-conductor: A material that has an electrical conductivity in between that of a metal and an insulator. Transistors and other electronic devices are made from semi conducting materials, and are often called semiconductors. Typical semiconductors for PV cells include silicon, gallium arsenide, copper indium diselenide, and cadmium telluride.

JAKEDA- Lighting up remote villages

One of the objectives of Jammu and Kashmir Energy Development Agency (JAKEDA) is to promote and implement projects aimed at meeting the energy requirements of remote and unelectrified areas of the State by harnessing new and renewable sources of energy.

By **S S Marazi**

Jammu and Kashmir, the northern most state in India, has some of the most beautiful landscapes in the country - but due to the geography and the current political situation, parts of the State remain inaccessible. Developing conventional infrastructure has been a challenge in the remote parts and electrification is one aspect of infrastructure that has faced problems in the inaccessible areas. The laying down of power transmission and distribution lines is not feasible in some cases due to the difficult terrain and the huge financial implications.

Considering that electricity is a much needed commodity, the government has looked for alternate means to provide the inhabitants of these remote areas with basic lighting facilities. One solution to addressing the problem in the State, is the solar home lighting project under the Remote Village Electrification (RVE) programme of the Ministry of New and Renewable Energy (MNRE), Government of India, being implemented by the Jammu and Kashmir

Energy Development Agency (JAKEDA).

JAKEDA is a State Nodal Agency (SNA) working under the administrative control of the Science and Technology Department, Jammu and Kashmir Government. It works for the promotion and implementation of projects aimed at meeting the energy requirements of the state in general and unelectrified areas in particular by harnessing new and renewable sources of energy such as solar, wind, biomass and small hydro. JAKEDA gets funds from MNRE as well as the State government for implementation of various projects in the State.

As part of the RVE programme, 1500 solar home light systems (SHLS) were installed in the Machil area of Kupwara District and 1052 SHLS in the Padder Block of Doda District of the State during the period 2006-07.

The modus operandi for implementation

As a first step, the unelectrified census villages and the remote hamlets of electrified census villages are identified. During 2008-09, in the Kashmir division a total of 68 such unelectrified villages and 67 unelectrified hamlets were identified for proposed coverage under the RVE programme. The Kashmir division covers the ten districts of Anantnag, Bandipora, Budgam, Baramulla, Ganderbal, Kupwara, Pulwama, Shopian, Kulgam and Srinagar. While in Jammu division the exercise identified a total of 41 such unelectrified villages and 1396 unelectrified hamlets for the same period. The Jammu division comprises the nine districts of Udhampur, Doda, Rajouri, Poonch, Jammu, Kathua, Ramban, Kishtwar and Reasi.

Next, a certification is obtained from the concerned power department/State Electricity Board (SEB), MNRE and the Renewable Energy Certificate (REC), GoI. The list of villages identified in both Kashmir and Jammu divisions in 2008-09 has been submitted by JAKEDA for the necessary vetting

A project report is then prepared by a consultant and the report is submitted to MNRE for obtaining the sanction and central financial assistance (CFA). Other means of finance are also explored. Finally when all aspects are in place the scheme can be implemented. The logistical support for the implementation is provided by the respective district authorities.

Remote Village Electrification

SHLSs were distributed in four areas of Kashmir division and three areas of Jammu division under the RVE Programme 2003-04, which was actually implemented in 2007-08 (Table 1). The target was to install a total of 8,297 SHLSs and the entire cost was estimated at Rs 1047.66 lakhs. This cost was to be shared by MNRE, the State and the beneficiaries.

SHLs distributed under RVE programme 2003-04

Kashmir Division		
S. No.	**Area**	**Households benefited**
1.	Kandi Kupwara	1156
2.	Jumagund	185
3.	Machil	1870
4.	Keran	1265
	TOTAL	**4476**
Jammu Division		
1.	Padder	1053
2.	Warwan	1025
3.	Marwah	1743
	TOTAL	**3821**

Kupwara District

Parts of Kupwara District border the Line of Control (LoC) in the thick of the Karakoram forests. The areas remain snowbound and 'cut off' for almost six months in a year and include: Machil, Keran, Kandi (Kupwara) and Jumagund. JAKEDA has provided 4,476 SHLSs in as many households, transforming the socio-economic scenario of the area. A total of 24 villages were covered and the cost of the project was Rs 565.18 lakhs. Out of this MNRE and the beneficiaries contributed Rs 429.25 and 33.57 lakhs, respectively, while the share of the State amounted to Rs 102.37 lakhs.

Kishtwar district

The mountainous terrain of Kishtwar district shares a border with Chamba district of Himachal Pradesh in the south. The remotest blocks of the district include Padder, Warwan and Marwah. The inhabitants from these blocks have to walk more than 50 kms on 'pony roads' to connect to a metal road. Here, JAKEDA has been successful in providing 3,821 SHLSs in as many households, helping to solve their basic lighting problem. Covering 26 villages the project cost was Rs 482.48 lakhs, of which MNRE and the beneficiaries contributed Rs 366.43 and 28.66 lakhs, respectively, while the State's share amounted to Rs 87.38 lakhs.

The programme undertaken by JAKEDA has been a huge success and has generated a tremendous response in the districts of Kupwara and Kishtwar, particularly in the blocks of Machil and Padder. ✪

The author is CEO of Jammu and Kashmir Energy Development Agency (JAKEDA).

A BRILLIANT START

The Solar Mission

The Ministry of New and Renewable Energy (MNRE) has done commendable work in terms of conceptualising, drafting, launching, and implementing the Jawaharlal Nehru National Solar Mission over the last one year.

By **Anil Patni**

The year 2010 will be marked as the year when Jawaharlal Nehru National Solar Mission (JNNSM) was launched in all earnestness. The Mission has already started showing signs of great promise for the future - in terms of upscaling and mainstreaming the use of solar energy as a sustainable source to address the intertwined issues of enhancing India's energy security and helping mitigate global warming and climate change. The JNNSM targets of generating 20,000 MW of grid connected and 2000 MW of off grid solar power by 2022 are truly impressive. By following the global experience of connecting solar power to the grid through megawatt scale solar power plants, India has joined the global solar bandwagon in a big way.

Teamwork by government agencies

The Ministry of New and Renewable Energy (MNRE) has done commendable work in terms of conceptualising, drafting, launching, and implementing the JNNSM over the last one year along with the Ministry of Power (MoP). The National Thermal Power Corporation (NTPC) has played a key role through the NTPC Vidyut Vyapar Nigam (NVVN) in organising the short listing of the applicants for setting up large solar projects in Phase 1 of the JNNSM (January 2010 - March 2013). Similarly, the Indian Renewable Energy Development Agency (IREDA) has played a vital role as the nodal agency for selection of applicants for the up to 2 MW capacity, rooftops PV and small solar power generation programme (RPSSGP). Of course, all these initiatives would not have been possible without the pivotal role of the Central Electricity Regulatory Commission (CERC) which came out with a levelised tariff for the solar power plants. This became the basis for the solar tariff set by the State Electricity Regulatory Commissions (SERCs) and in many cases the SERCs decided to emulate the CERC tariffs.

It is laudable that all these government ministries and agencies worked in tandem to launch the first set of large commercial plants under the JNNSM and it is creditable that we have some 900 MW of solar power plants already underway in the first year of the Solar Mission.

Technology allocation

MNRE suggested allocation of 60 per cent of the projects in the Mission for concentrated solar thermal (CST) and 40 per cent for solar photovoltaic (PV) technology, in its effort to try out other technologies. After discussion with the Indian solar industry, the government has adjusted the allocation to 50-50 between thermal and PV. In India, the PV technology has established itself over the past two decades and there are some 40 manufacturers of solar PV modules in the country today. In comparison CST technology is yet to develop a manufacturing base. The Government can validate CST in the Indian context by way of demonstration projects and subsequently on a commercial scale. While there are specific advantages for PV, such as its ability to be applied at micro scale in terms of individual products like solar home lights and lanterns as well as at rooftop PV systems and megawatt scale plants; CST also has its advantages such as its capability to hybridize with gas and other sources and the capacity for power storage, though the costs for storage are prohibitively high at present.

NVVN bidding

The government went for reverse bidding for the 5 MW PV projects totalling 150 MW and for the 10-100 MW CST projects totalling 470 MW. The bidding was organised by NVVN based on highest discount offers. This resulted in aggressive bidding and the resultant tariffs of Rs 11 to 12.50 per kWh are as much as 30-40 per cent lower than the CERC tariff of Rs 17.91, which was set after due diligence and taking into account the Indian and global solar industry data as well as discussion in an open public hearing. The aggressive bidding has enabled new enthusiastic players to enter the Indian solar market, who can seek assistance from the Ministry and banks for funding as well as technology, for the success of the JNNSM. The Ministry may look at addressing the gap in solar tariff in the next round of bidding. CERC tariffs for the whole country can be adjusted region wise such that eastern and north eastern parts of India also receive solar investments.

Made in India

The Ministry has mandated use of indigenous PV modules in Phase 1 of JNNSM. This proviso will be extended to the use of indigenous cells in the next phase. The move has been

> **Hopefully, 2011 will be the year when solar products and systems will become a consumer item, which can be bought off the shelf in shops and markets.**

100 kW Tangtse Solar Power Plant, Ladakh

welcomed, since it gives a level playing field to the Indian PV manufacturing industry. The proviso applies to the use of crystalline silicon (C-Si) modules - an established technology accounting for 85 per cent of the global market. However, import of non C-Si modules like thin film (amorphous silicon, cadmium telluride etc.) have been possible. This has led to a situation where the overstretched-for-low-cost projects in the NVVN list may import thin film technology without considering the long term sustainability and performance guarantee of the projects. The provision is necessary to attract further investments for the manufacturing of solar PV into India. The numerous announcements made by Indian and foreign players to start PV manufacturing in India show that the move is in the right direction. The state governments, which are implementing ambitious solar power plans, should be encouraged to include a 'Made in India' clause in their respective policies.

Off grid

The Ministry's idea to create a range of channel partners like system integrators, banks and micro finance institutions (MFIs), NGOs, financial integrators and renewable energy service companies, apart from the State Nodal Agencies (SNAs), to implement off grid projects and obtain subsidy directly from the MNRE is a good one. It augments the process of implementation of the off grid segment of the JNNSM which foresees a target of 200 MW in Phase 1 and 2000 MW by 2022. These channel partners will have to get themselves rated or accredited through agencies appointed for the purpose (CRISIL or ICRA etc.) and based upon the rating they can submit their project proposals. Each project proposal can accumulate different off grid initiatives totalling 1 MW at a time. This is a sound idea to effectively and efficiently get projects implemented. However, the critical factor for success will be the speed and ease with which the channel partners get their payment from the government. One suggestion is to make the entire transaction online, including submission of project proposal to MNRE's committee, tracking of the application, and finally payment of the subsidy to the channel partner/ beneficiary - so that human interface and consequent delays are eliminated.

Off grid and decentralised renewable energy applications are the most appropriate for a vast and rural country like India where the grid cannot be extended everywhere. We have the successful example of Chhattisgarh where almost 900 village level micro plants are running on solar energy for the last 2 to 3 years. This model can easily be extended to the neighbouring states of Bihar, Jharkhand and Orissa where the conventional electricity supply in rural areas is similarly hindered. Further, there is the example of Uttar Pradesh where one company has sold more than 1,10,000 solar home lighting systems. This can be amplified to cover all unelectrified households in the country. This is sought to be achieved by roping in regional rural banks through the National Bank for Agriculture and Rural Development (NABARD) - another welcome step.

Capacity building, research and development

The inaugural year of the JNNSM was perhaps rightly spent in getting the first batch of projects off the ground but in its second year the Mission must focus on some core and essential areas such as capacity building and promoting research and development. The MNRE has recently prepared a human resource development plan for the renewable energy sector. This should be implemented in earnest through close cooperation with the Indian industry because shortage of trained and skilled manpower is already being felt by the Indian solar industry due to its current relatively small size.

One of the most important targets for JNNSM is to achieve grid parity of solar power by 2022. This is sought to be accomplished by generating large volumes to drive down costs by bringing in the play of economies of scale in manufacturing and project implementation. The second aspect of this strategy has to be result oriented technological research and development. The JNNSM document talks about setting up a national council to promote solar research. There is no doubt that there is a need to enhance the level of research to find new materials, improve efficiency of the existing ones, reduce the cost and improve the efficiency of balance of systems (BOS), optimise solar power through tracking mechanisms and make storage of power cost effective and long lasting etc. The government can come out with another policy like the Special Incentive Package Scheme (SIPS) which allows for 20-25 per cent grant for the setting up of solar PV manufacturing, subject to a minimum investment of Rs 1000 crore. The new policy should be pegged at lower threshold levels and must include polysilicon and wafer manufacturing as well as BOS.

1 MW NDPL solar PV array

> **Off grid and decentralised renewable energy applications are the most appropriate for a vast and rural country like India where the grid cannot be extended everywhere.**

Hopefully, 2011 will be the year when solar products and systems will become a consumer item, which can be bought off the shelf in shops and markets. For this to happen, it is essential that the respective regulatory agencies fix solar rooftop tariffs and the respective state governments extend support in the form of capital subsidies to make rooftop solar power systems affordable. If this is done in mission mode, individual consumers will be incentivised to start setting up their own rooftop solar power plants, as has been the experience in Germany. This idea could help solve the current problem of 12 per cent demand supply gap in the power sector.

Road ahead

The first year of the Solar Mission has been an eventful one. We need to keep up the momentum with the immediate goal being the timely and successful achievement of the Phase 1 targets and the next goal being to prepare for Phase 2 based upon the experience and learning from Phase 1. If all of us, from the industry and government join hands with a positive and proactive approach, we can surely achieve it. ✪

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Solar PV and integrated devices

towards achieving the Solar Mission goals

The role of appropriate solar devices for multiple uses would enable supplementation of a huge supply of energy on one hand and on the other help in achieving some of the goals of Jawaharlal Nehru National Solar Mission (JNNSM) while equipping the rural masses simultaneously for a better livelihood.

By **Dr P C Pande**

JNNSM aims at deploying 20000 MW of solar power by 2022, an apt and marvellous plan. However, it cannot be based only on the installation of solar thermal or photovoltaic (PV) plants with certain concessions. The role of appropriate integrated solar devices capable of varied usage would enable supplementation of a huge supply of solar energy on one hand and

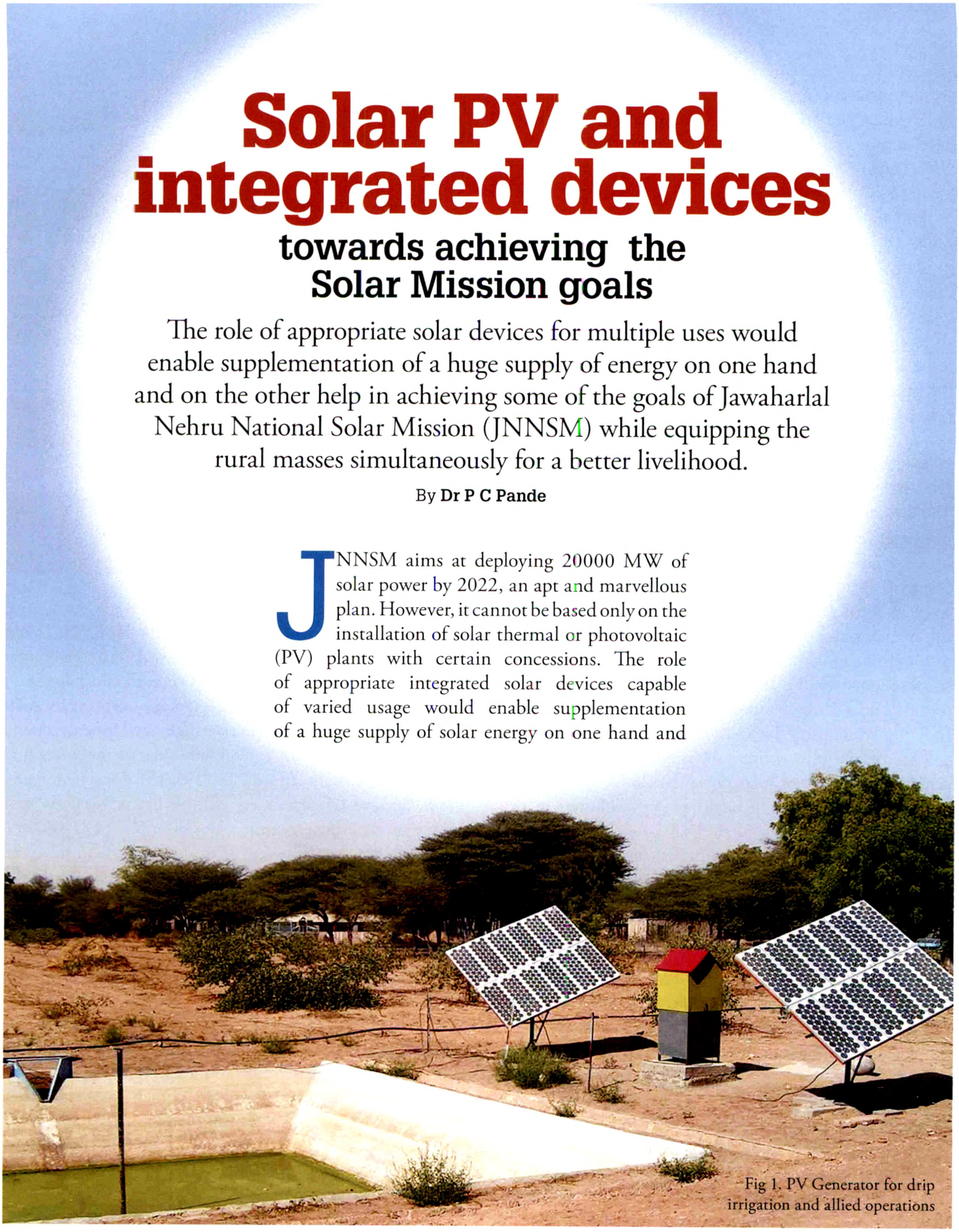


Fig 1. PV Generator for drip irrigation and allied operations

on the other help in achieving some of the goals of the JNNSM while equipping the rural masses with a better livelihood. Although, use of a few solar devices like water heaters, solar lighting systems etc., have been considered, there are several other applications that relate to the rural economy and are useful from the farmers' perspective. In this connection the outcome of extensive work, carried out at the Central Arid Zone Research Institute (CAZRI) bears relevance. Different solar thermal devices like solar water heaters, cookers, stills, dryers, polish making machines and PV systems for rural and agricultural applications have been developed and evaluated earlier at CAZRI. Of late the focus has shifted to the development of integrated multipurpose solar devices to enhance utility and practicability. A few novel PV systems and integrated solar devices designed and developed by the author are enumerated here. These multipurpose integrated solar devices may be considered as a part of the programme to quench the much needed energy thirst, especially in rural India.

Three-in-one solar integrated device

This unique integrated solar device (Fig 2) can be used as a solar water heater during the winter, a solar cooker during clear days and a solar dryer for fruits or vegetables. It can produce about 50 lt of hot water of 50-60°C utilising the low altitude position of sun during winter and food for a family can be boiled within 2-3 hours, when used as a solar cooker and that too without sun tracking. As a dryer, fruits and vegetables can be dehydrated efficiently with regulation of temperature during the day with water working as a sink regulating temperature and helps continuation of the drying process in the night through the solar heated water.

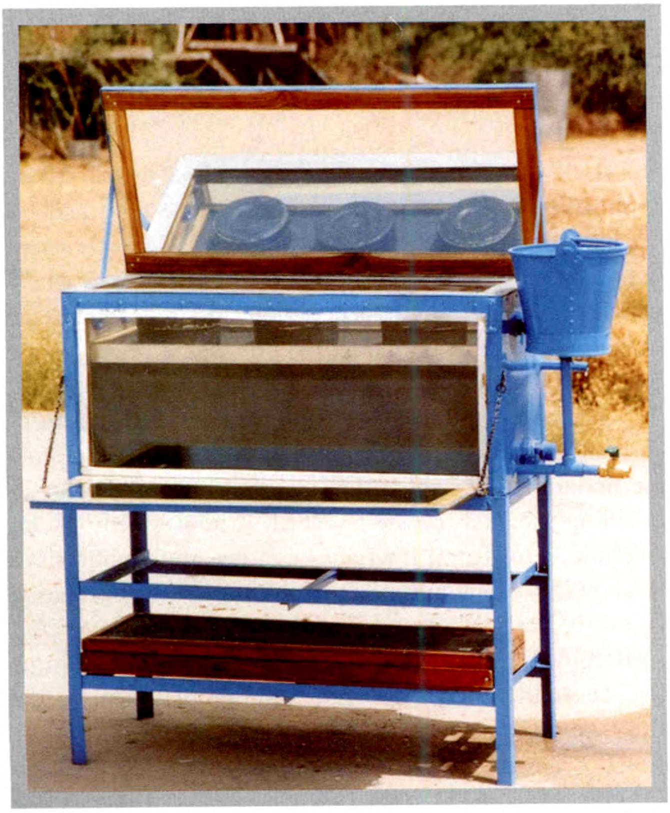


Fig 2. Integrated triple purpose solar device

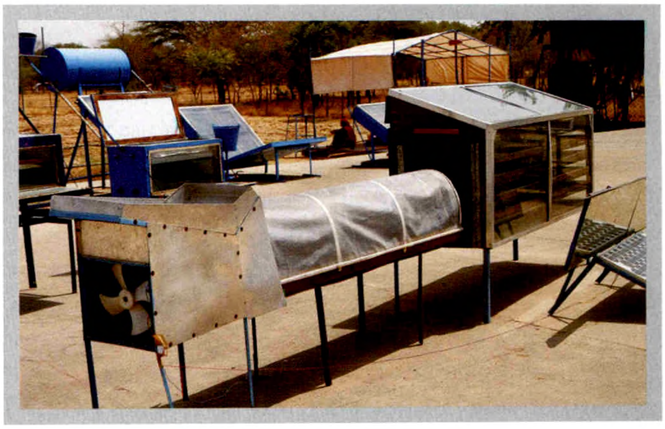


Fig 3. PV winnower cum dryer

PV winnower cum dryer cum illuminating system

Solar PV winnower cum dryer (Fig 3) is a convenient device for winnowing threshed agricultural produce, especially during the period of lull in natural winds and also for dehydrating fruits and vegetables with forced circulation of air. The system comprises a PV module, a compatible winnower, a pre-air heating tunnel, a especially designed solar drying cabinet with proper interconnections to use the fan of the winnower for enhanced air circulation while dehydrating the produce. Used as a winnower 35-50 kg of cleaned grains/seeds can be obtained in one hour from this device.

In addition, different fruits and vegetables can be dehydrated in less than half the time as compared to open sun drying. The enhancement in the fan speed with more irradiance regulates the temperature while the pre-air heating in the extended tunnel reduces the thermal gradient inside the drying cabinet. Thus excellent quality of the dried material is achieved with the retention of aroma and colour. The system can be provided with additional features for illumination with incorporation of a battery and charge regulator, thus making it an extremely useful device for processing different agricultural produce and utilising the generated PV electricity for one or another purpose throughout the year.

PV generator for orchards

It is primarily a solar PV pump operated drip irrigation system comprising 900 W PV array with 800 W DC motor pump mono block and OLPC drippers that economise the use of water and eliminate practically all the problems associated with flood irrigation and is suitable for orchards. The system needs to be designed on the basis of water requirement of the plant, energy need and compensation of varying pressure due to change in irradiance ensuring uniform application of the water in the field. It can command 4-5 hectares of pomegranate orchard with cost benefit ratio of more than 2 and may prove to be a boon in farms where water and land are available but the area is devoid of electrical power.

The PV system for irrigation has now been converted to a generator (Fig 1) with sub components like DC-DC converter, storage batteries and compatible inverter so that it can be used for running small machines to carry out post harvest operations in addition to its utility as a pump.

Solar PV duster

Plant protection is an important component of agriculture. Solar PV duster (Fig 4) is a novel device suitable for dusting insecticide and pesticide powder on crops. It essentially comprises a PV panel carrier, a storage battery and a specially designed compatible dusting unit. The PV panel, carried over the head with the help of a carrier, provides shade to the worker and simultaneously charges the battery to run the duster. The same system can run an ultra low volume (ULV) sprayer also. In addition, it can be used to illuminate a light emitting diode (LED). The device can be used for lighting the house throughout the year and for operating the duster/sprayer as and when required.

PV mobile unit

The self propelling PV mobile unit (Fig 5) is a moveable self propelling power system that can be used to accomplish domestic, agricultural and rural oriented tasks in isolated cluster of houses in rural areas, especially in *dhanis* (hamlets) of the arid areas. The unit comprises of two 70 W polycrystalline PV modules connected to a charge regulator, a folding system with auto locking arrangement for keeping the PV panels (70 W) at an optimum angle, an inverter and a DC motor operated drive system. The unit can be driven with ease and can be used for operating both AC and DC loads. The system has been successfully tested for operating a churner to extract butter, a blower, a winnower, an aloe vera extractor etc. Such PV mobile units can be used on a custom hire basis in the villages.

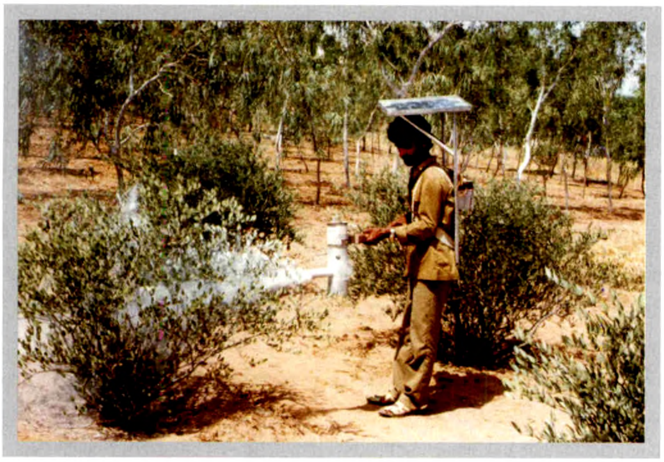


Fig 4. Solar PV duster

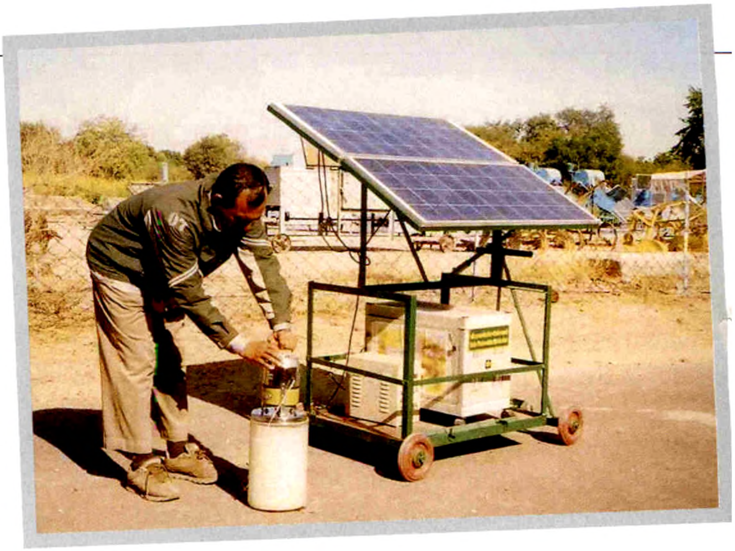
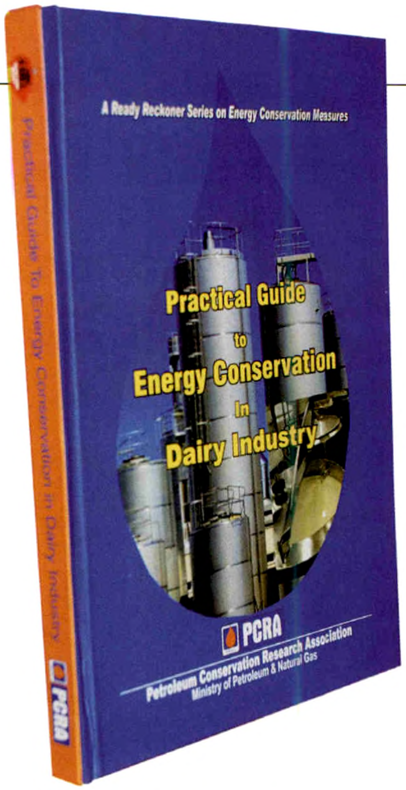


Fig 5. Operation of butter churner by PV mobile unit

Epilogue

Novel PV and integrated devices for multipurpose applications are easy to adopt and can be modified on the basis of requirements. Most of these can be fabricated with ease and are of high utility in the rural areas where agriculture is the main occupation and related cottage industries are to be developed. While bigger power plants for power generation are welcome, such devices of practical importance will also remain in demand. Development of cottage industries in villages with solar electrical supply for manufacturing these devices can contribute a lot in fulfilling the goals of the JNNSM. A new system - Solar Appliances for Rural Energy Guarantee and Applications (SAREGA), along the pattern of the existing Mahatma Gandhi National Rural Employment Guarantee Act (NREGA) may prove to be a self sustaining programme for generating energy and providing employment to the rural youth. ✪

The author is Principal Scientist, Central Arid Zone Research Institute (CAZRI), Jodhpur.


A Ready Reckoner Series on Energy Conservation Measures
Practical Guide to Energy Conservation in Dairy Industry
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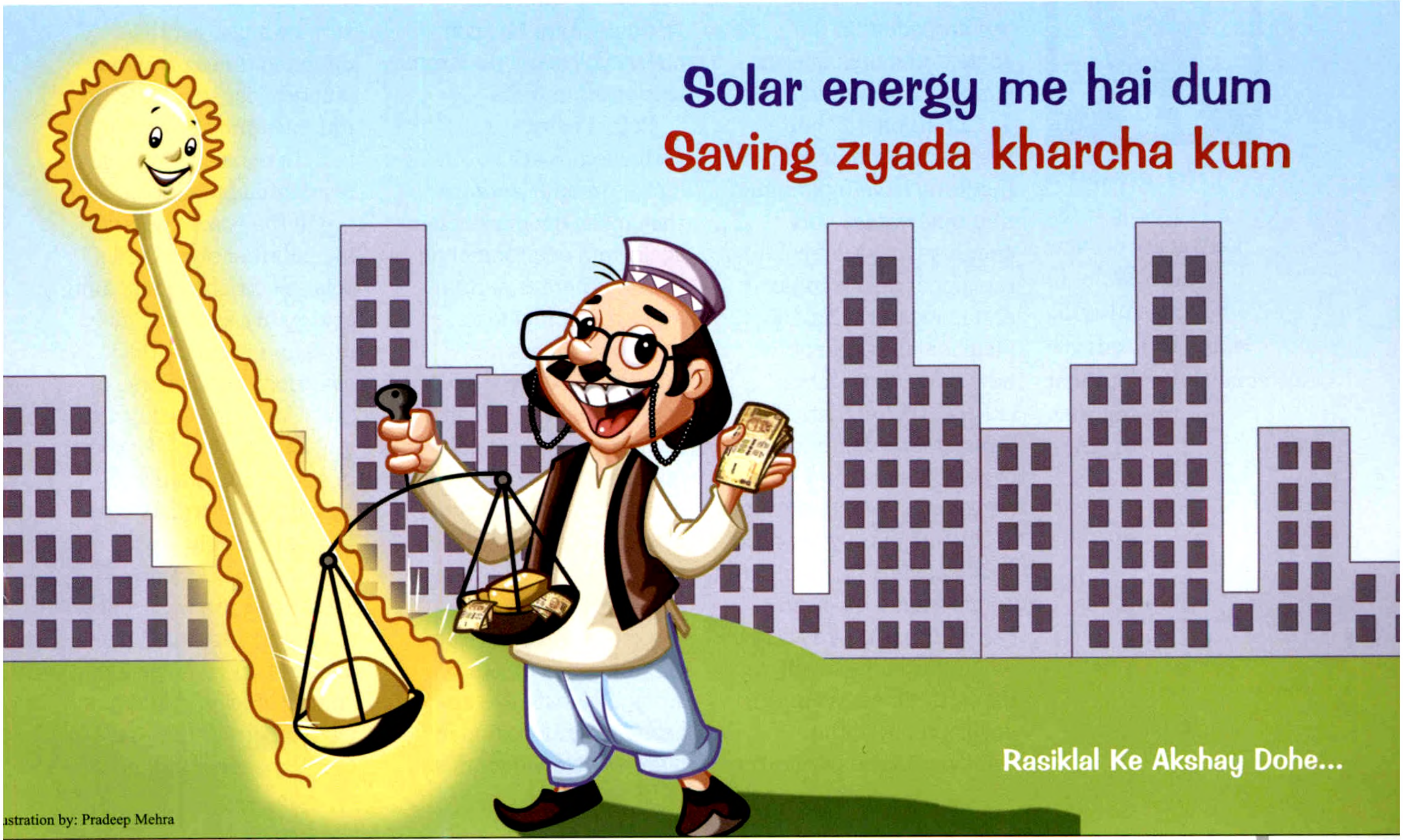
Practical Guide to Energy Conservation in Dairy Industry
Hardcover: 205 pages
Cover price: Rs 175
Publisher: Petroleum Conservation Research Association, Ministry of Petroleum and Natural Gas, Government of India.
ISBN: 978-81-908167-1-7
Website: http://www.pcra.org

A Guide to Energy Conservation in Dairy Industry

India has been the world's largest producer of milk since a decade. The dairy industry however, is largely unorganised and local in its character. Petroleum Conservation Research Association (PCRA) has carried out energy audits of over 100 dairy plants in the country with the aim to create a comprehensive guide for dairy professionals in conserving energy. The book provides step wise, practical tips to save energy in all major areas of a dairy processing plant. It shows use of instruments required for conducting energy audits; and, latest and efficient energy saving technologies like co-generation, tri-generation, use of light emitting diode (LED) etc. Some other interesting and unconventional energy conservation opportunities covered in the book are on effluent treatment plants, water conservation and audit, waste minimisation and resource conservation etc. I hope that this book will be helpful for dairy professionals and companies engaged in the energy sector and serve in conserving energy in the dairy industry.

R K Khilnani, Energy consultant



istration by: Pradeep Mehra

Decentralised solar:

An option for both urban and rural development

Solar energy technologies are no longer just a 'greenie' option – they make good economic, social and environmental sense. Whereas in rural areas they provide for improved access and amenity; I believe that it is in urban areas where the biggest impact and opportunity lies.

Deo Prasad is a Professor at the University of New South Wales in Sydney, Australia where he heads the sustainable development programme.

There is considerable evidence to suggest that by 2010 we had reached what is known as the 'tipping point' in the context of global energy supply. Experts such as Christopher Flavin, President, Worldwatch Institute, have highlighted that renewables now comprise about a quarter of the global power capacity and in excess of half of all global investment in new power generation (REN21 Global Status Report). The geography of development and deployment of technologies is shifting mainly towards Asia Pacific. Furthermore policy leadership is now beginning to move east as well. This augers well, as the need for community development in the countries of the region coupled with low carbon options provides for a sustainable living future. The Jawaharlal Nehru National Solar Mission (JNNSM) clearly underpins this effort in India.

Solar energy technologies are no longer just a 'greenie' option – they make good economic, social and environmental sense. Whereas in rural areas they provide for improved access and amenity; I believe that it is in urban areas where the biggest impact and opportunity lies. With grid connection technologies now mature, leading utilities are championing grid connected solar. Generally speaking, the elimination of onsite storage sounds like an economic proposition in many developed markets. However, the insecurity of power supply in many developing countries makes solar photovoltaics/battery storage a competitive option in times of power outages, especially for uninterrupted power supply in both residential and non-residential buildings.

On the economic front, in a number of countries solar electricity is reaching grid parity as the costs drop and normal grid electricity costs increase (e.g. Germany, California, and soon Sydney). However in addition to simply looking at electricity cost as a way of calculating payback, many people these days prefer to link it to property values. There is increasing evidence that energy efficient buildings fetch a better price - up to 5-15 per cent higher

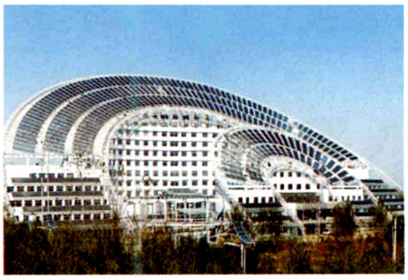


Fig 1. Modern design - Himin Solar, China

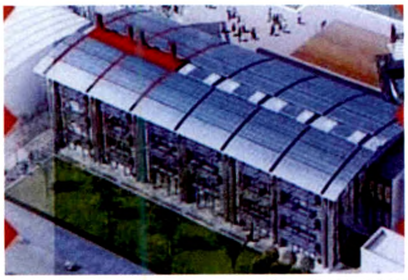


Fig 2. Singapore Zero Energy building (BCA, 2010)

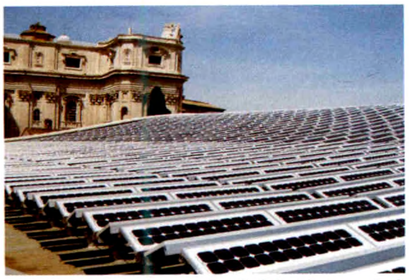


Fig 3. Heritage design - Roof of the Vatican, Italy

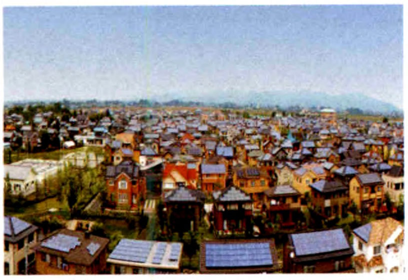


Fig 4. Urban scale solar in Japan (Ota Gunma)

(rental or resale). As market sophistication increases this will be the case. Hence one can find that straight payback for solar systems can be less than a year as property values increase rapidly in most markets. This implies that such technologies need to serve value added functions - act as the roof, cladding or awning and not just be placed on top of existing envelopes.

The architectural character of the technology is very important if it is to gain wide scale acceptance (Fig 1- 4). Hence the technology, design and integration are all very important. Furthermore the links between end use efficiency of energy and solar energy generation are important – the first step is to ensure energy is being used efficiently and then explore renewable energy generation options.

Increasingly we are finding that countries are adopting low energy/ carbon standards for buildings. The United Kingdom has moved towards a zero carbon target and the EU is considering net zero energy buildings – all in the next five to ten years. This implies considerable opportunity for new technologies and tools which can help deliver such outcomes. The Singapore Government has recently completed its net zero energy building (BCA website) as shown in Fig 2. This is a global trend now and the challenge is to meet performance goals as well as architectural ones. Urban scale deployment of solar technologies has implications on both interconnection and grid logistics as well as urban aesthetics. Hence design, planning and performance are all important.

A good policy is crucial for delivering quality solar projects. The feed-in-tariff has become a key instrument to up scale solar implementation. In most countries this has ranged upwards of USD 0.30 per kWh and in some countries has been more than double that (in Sydney AUD 0.60 and in Ontario CAD 0.80). In a recent report titled 'Deploying Renewables – principles for effective policies' the International Energy Agency highlighted the need to remove non economic barriers; the need for a predictable and transparent support framework to attract investments; introduction of transitional incentives to foster and monitor innovation; the development and implementation of appropriate incentives for different technologies depending on degree of maturity; and due consideration of the impact of large scale penetration of renewables on the overall energy system. One of the biggest reasons for investment in renewables is the potential for industry development and employment, hence the rush by some countries to ensure a good investment climate.

India is very well placed to play a major role in innovation and industry development in this area. Given the opportunity for environmental, economic and social development with this increasingly important technology area, it is an opportune time to act. ✪

NVVN AND THE SOLAR MISSION

NTPC Vidyut Vyapar Nigam Limited (NVVN) was formed by the National Thermal Power Corporation (NTPC) Limited, as a wholly owned subsidiary with a vision to be a catalyst in the development of the wholesale power market in India, enabling the trading of surplus power.

By **Kundan Burnwal**

India requires a paradigm shift from economic activities based on fossil fuels to one based on non fossil fuels and from reliance on non renewable and depleting sources of energy to renewable sources. In June 2008 the National Action Plan on Climate Change (NAPCC) identified development of solar energy technologies in the country as one of the national missions. Consequently in 2010, the Jawaharlal Nehru National Solar Mission (JNNSM) was announced as a major initiative of the Government of India (GoI). JNNSM aims to promote an ecologically sustainable growth while addressing India's energy security challenge and establish India as a global leader in solar energy, by creating policy conditions for its diffusion across the country as quickly as possible. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change.

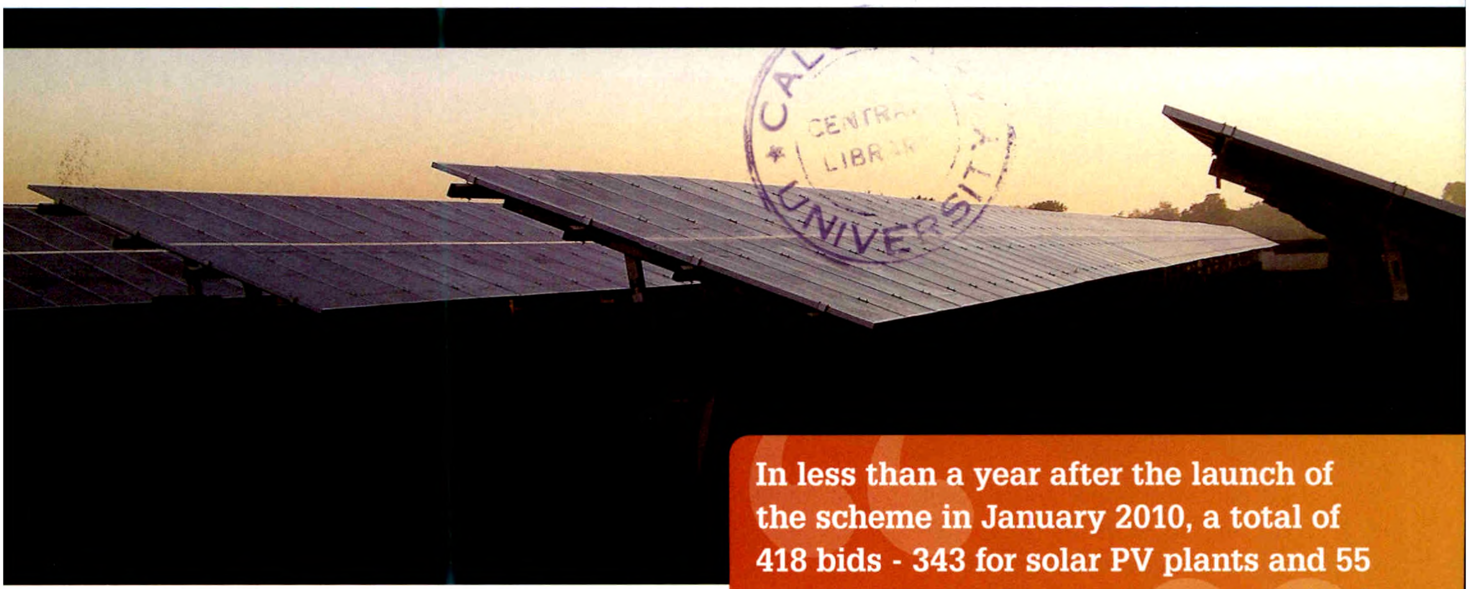
Formation of NVVN

NTPC Vidyut Vyapar Nigam Limited (NVVN) was created by the National Thermal Power Corporation

(NTPC) Limited, as a wholly owned subsidiary with a vision to be a catalyst in the development of the wholesale power market in India, enabling the trading of surplus power. NVVN was incorporated on 1 November 2002 with the main objective of carrying on the business of purchase and sale of all forms of electrical power, both conventional and non conventional. It was also to supply, import, export or otherwise deal with all aspects of electrical energy. It was decided by the Ministry of New and Renewable Energy (MNRE), Government of India, that the implementation of the target up to March 2013, of 1000 MW of grid connected (33 KV and above) solar power plants under the JNNSM will be through NVVN. This capacity of 1000 MW has been divided equally between solar photovoltaic (PV) and solar thermal projects.

NVVN's role in JNNSM

NVVN has been appointed as the nodal agency for entering into power purchase agreements (PPAs) with solar power generation project developers, and will directly purchase the solar power as per the norms and guidelines fixed by the Central Electricity Regulatory Commission (CERC). That is, it will be the nodal agency for sale and purchase of grid connected solar power. Under JNNSM two types of schemes are proposed (i) the migration scheme and (ii) the new project scheme.



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For each MW installed capacity of solar power for which a PPA is signed by NVVN, the Ministry of Power (MoP) shall allocate to NVVN an equivalent amount of MW capacity from the unallocated quota of NTPC coal based stations and NVVN will supply this bundled power to the distribution utilities. Performance guarantee is to be provided by the project developer to NVVN as a bank guarantee on the basis of Rs 50 lakh per MW of the total project capacity; 50 per cent of which is to be provided before signing the memorandum of understanding (MoU) and the balance 50 per cent before signing the PPA. In case of failure of the project developer to execute the PPA within the stipulated time period, the bank guarantee shall be encashed by NVVN. From the date of signing of the PPA the bank guarantees shall be valid for 15 and 31 months for PV and solar thermal projects, respectively.

In less than a year after the launch of the scheme, 343 bids for solar PV plants and 55 for solar thermal projects were received by NVVN. In Rajasthan, Maharashtra and Punjab 16 applicants with a total solar capacity of 84 MW (54 PV and 30 thermal) qualified for migration to JNNSM. On 24 July 2010 NVVN entered into an MoU with these applicants, while the PPA for the qualified solar capacity was signed on 15 October 2010. Indian Renewable Energy Development Agency Limited (IREDA) has already selected about 184 MW of grid connected plants.

> **In less than a year after the launch of the scheme in January 2010, a total of 418 bids - 343 for solar PV plants and 55 for solar thermal projects were received by NVVN.**

NVVN received an overwhelming response of over 400 interested project developers to its request for selection (RfS) document, for selection of new grid connected solar power projects under JNNSM. The document was prepared on the basis of the MNRE guidelines for new grid connected solar power projects. After evaluation of the received applications, short listed solar power project developers were informed and their bids were opened on 16 November 2010. The eligible bids offered a range of discounts and the average rate for selected plants was Rs 12.16 per unit for solar PV and Rs 11.48 per unit for solar thermal plants. NVVN had invited bids for 620 MW capacity (see table) and had shortlisted 30 solar power project developers for 150 MW of solar PV capacity and 7 solar power project developers for 470 MW solar thermal capacity. Letters inviting expression of interest (EoI) from various state utilities/discoms for purchase of solar power under Phase 1 of JNNSM have been sent out in November 2010. As on 11 January 2011 power purchase agreements of 800 MW capacity have been signed with investors and implementation is underway.

List of projects selected under JNNSM Phase 1 Batch 1 by NVVN

State	Solar project type	Capacity (MW)
Maharashtra	PV	5
Rajasthan	PV & thermal	505 (105 PV & 400 thermal)
Karnataka	PV	10
Andhra Pradesh	PV & thermal	65 (15 PV & 50 thermal)
Uttar Pradesh	PV	5
Tamil Nadu	PV	5
Orissa	PV	5
Gujarat	Thermal	20
Total		**620**

Future perspective

NVVN will play a very important role in the implementation of JNNSM in the years to come. NVVN has several competitive advantages, which include;

- It is promoted by NTPC Limited, one of the biggest energy operators in the country. NTPC has an excellent track record in creating energy infrastructure in India and provides a strong managerial, technical and financial background to NVVN.
- It has an excellent asset back up - NTPC's existing capacity is 32694 MW and it plans to be a 50,000 MW plus entity by 2012 and a 75,000 MW company by the end of 2017.
- NTPC has a strong network with existing utilities, which is one of the important drivers in the trading industry. This helps NVVN to easily establish rapport and credibility with potential buyers and sellers.
- NVVN being a 100 per cent owned subsidiary of NTPC Limited, is also a government company under the Companies Act 1956. NVVN would thus enjoy strong credibility in the market.
- NVVN employees have been drawn from the professional manpower of NTPC. Most of them are engineers and charted accountants having extensive experience in dealing with various technical and commercial issues in NTPC.

With the government having done its bit, now it is up to the industry to make India the solar capital of the world, in the years to come. ✪

The author is from the Climate Change Mitigation Unit, German International Cooperation (GIZ)

Solar COOKER

Simple things which are readily available around the house can be used to create a solar cooker. In your 'do it yourself' solar cooker you can cook a delicious meal without lighting a match.

Do you fancy an exotic meal cooked for several hours under the hot blazing Indian sun? Well, here is how to go about it. Visit your nearest grocer and get hold of two reasonably large cardboard boxes - a size that can hold two large bowls with some room to spare. One box should fit into the other. Collect and crush a few old newspapers, better still if you can get some straw. These will be used for insulation.

Now, the tricky part - the lid of the inner box. You will need a transparent glass cut to the dimensions of the top of the box. Besides the above, check that you have all the materials listed in the box alongside. Now you can sit down to assemble and create your very own solar cooker.

The inner Box. Clean out the box, tape up all the sides except the top. Ensure that the box is sturdy. With a pair of sharp scissors cut off the top four top flaps of the inner box. Tape up the rough edges. Now, paint the inside of the box a very very dark black - preferably using acrylic paint. Leave the box to dry.

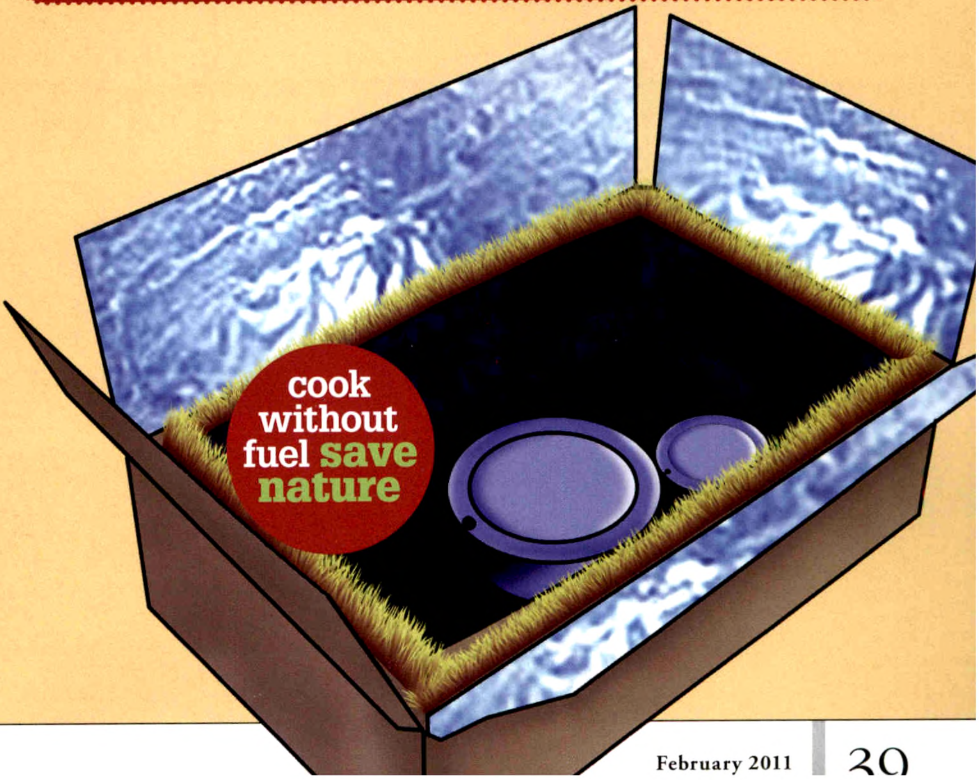
The outer box. Clean out the box, tape up all the sides except the top. Ensure that the box is strong. With the scissors cut out large pieces of aluminium foil - the kind that is used to wrap food. Paste the pieces on the inner side of the four top flaps. Leave the box to dry.

The insulation Use materials that are poor conductors of heat - rolled up newspaper, straw, husk etc. Place a layer of this material at the bottom of the big box and then place the smaller box on top. Next, fill out the gaps between the four sides of the boxes tightly with insulation material. Once this is done the two boxes should become one unit.

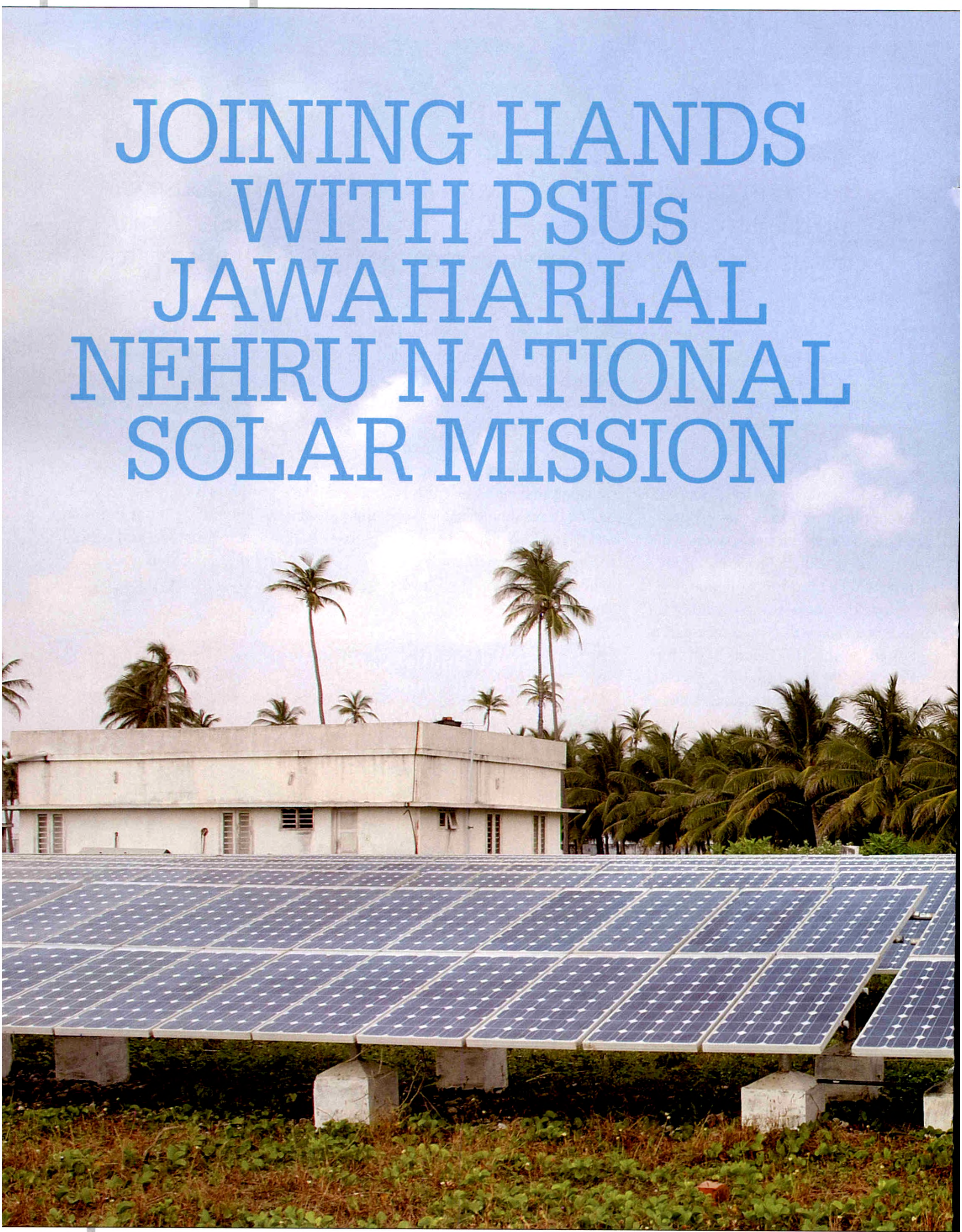
The glass top Place the glass top on the inner box. You are now all set to make a delicious meal with your very own solar cooker.

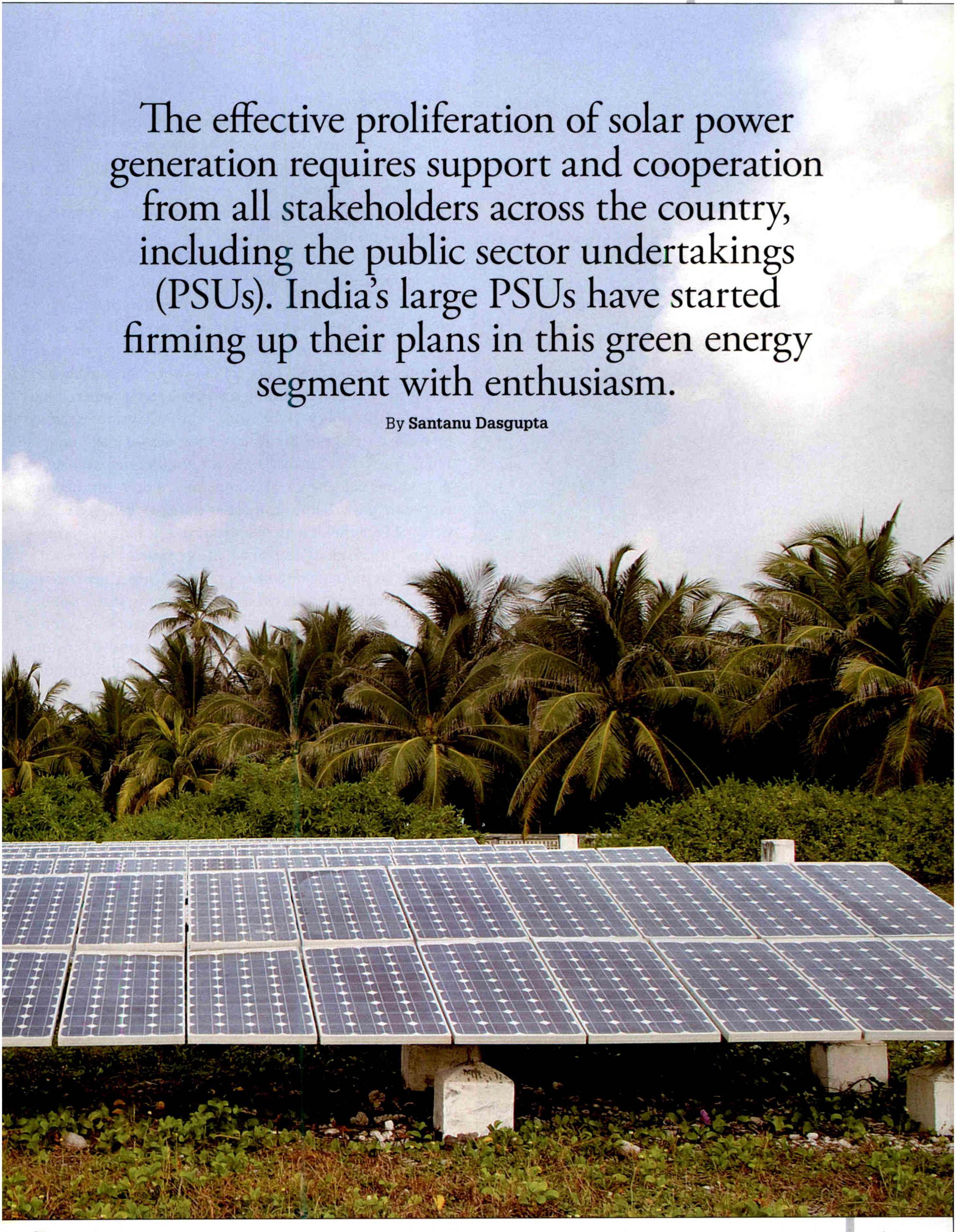
The meal Select two non reflective bowls with lids. In one bowl put half a cup of washed rice and pour two cups of water. In the other bowl mix your favourite vegetable with a spoonful of oil, salt to taste, a pinch of turmeric and green chillies. Place both bowls carefully in your solar cooker and set it out in the sun. Wait for two hours - lo and behold you have delicious food ready, cooked only with the pure goodness of nature.

1 big and 1 smaller cardboard box; aluminium foil; black acrylic paint; packing tape; scissors; glass sheet; 2 aluminium bowls with metal lids; half bowl rice; vegetable of choice and spices.


cook without fuel save nature

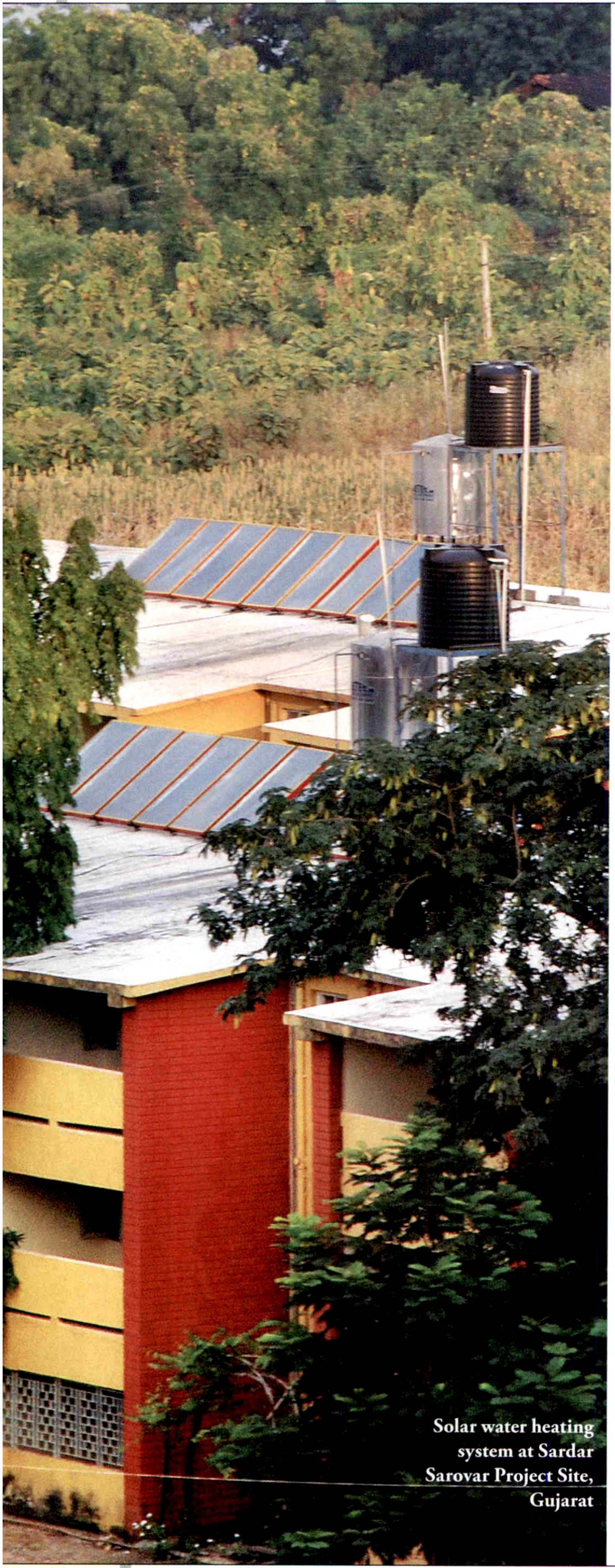
JOINING HANDS WITH PSUs JAWAHARLAL NEHRU NATIONAL SOLAR MISSION





The effective proliferation of solar power generation requires support and cooperation from all stakeholders across the country, including the public sector undertakings (PSUs). India's large PSUs have started firming up their plans in this green energy segment with enthusiasm.

By **Santanu Dasgupta**



Solar water heating system at Sardar Sarovar Project Site, Gujarat

The Jawaharlal Nehru National Solar Mission (JNNSM) is poised to crown India as the global leader in solar energy, by enabling the policy to diffuse across the country in the shortest possible time. The Mission has set a target of 20000 MW and proposes to meet it in 3 phases for various items under consideration, including grid connected solar power. The effective execution of the JNNSM requires the identification of resources to overcome the financial, technological, institutional and other obstacles that may pose challenges to the development of solar power in India. The effective proliferation of solar power generation, therefore, requires support and cooperation from all stakeholders across the country, including the public sector undertakings (PSUs). The policy framework of the Mission is aimed to facilitate the process of achieving grid parity latest by 2022. The policy further aims at uninterrupted availability of commercial energy at competitive prices for national economic growth and to meet at least partially the energy needs of households with safe, clean and sustainable forms of energy. In addition, diversified energy sources of renewable energy can promote multiple options for energy generation.

Solar energy appears to be one of the most viable options in the Indian scenario, since India is a tropical country blessed with abundant medium to high intensity sunshine for long hours per day. Further, decentralised distribution of energy is a natural derivative of development of solar alternatives that can aptly empower people even at the grassroots level. The challenging task of implementation of the JNNSM is entrusted to the Ministry of New and Renewable Energy (MNRE), Government of India.

Thus solar energy in India is poised to be one of the most formidable opportunities in the 21st century for the energy sector. Combining the government's strong initiative with India's locational advantage for solar energy presents a win-win combination. The other contributory factor towards such an extraordinary development could be India's huge energy deficit coupled with its faster economic growth that may usher in a hitherto unimaginable investment scenario. No wonder that India's large PSUs have started firming up their plans in this green energy segment with enthusiasm. PSUs like Indian Oil Corporation (IOC), Oil and Natural Gas Corporation (ONGC), Bharat Petroleum Corporation Limited (BPCL), National Thermal Power Corporation (NTPC), Bharat Heavy Electricals Limited (BHEL) etc., have all announced big ticket investments into solar energy apart from big players in the private sector. PSUs are set to play a pivotal role in the success of the JNNSM.

PSUs' participation in government bidding

Designated as the nodal agency, NTPC Vidyut Vyapar Nigam Limited (NVVN), a wholly owned subsidiary of NTPC will procure solar power from project developers under the Mission. ONGC, GAIL (India) Limited, Steel Authority of India Limited (SAIL), and IOC were among the companies which had been invited by NVVN, which acts as a trading arm of NTPC, to submit bids for developing solar projects under Phase 1 of the Mission. Competing with the public sector majors were private players like Lanco, Larson & Tubro (L&T), Punj Lloyd, Essar Power, Welspun Energy, Moser Baer, and Reliance Power. In order to avoid cartelisation, NVVN individually notified the companies that had made requests for selection (RfS) under the Mission. It has been gathered that NVVN received 418 RfS of solar projects, both PV and thermal from various developers. Of these, it has received 343 applications for solar PV and 55 for solar thermal. RfS were called for developing 150 MW of solar PV projects with a capacity of 5 MW each and 470 MW of solar thermal projects with a minimum capacity of 20 MW and maximum of 100 MW each.

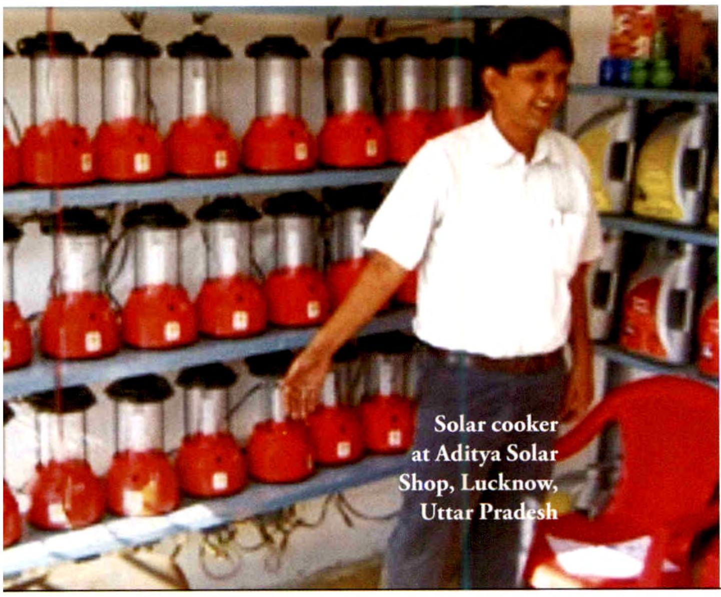
> **With the Indian government making a strong commitment towards solar energy, the PSUs have planned investments in solar energy as a part of their strategic growth mission.**

Solar plans of PSU companies

India has huge state run PSUs like NTPC, BHEL, Bharat Electronics Limited (BEL), ONGC, Oil India Limited (OIL), IOC, Hindustan Petroleum Corporation Limited (HPCL), BPCL etc. With the Indian government making a strong commitment towards solar energy, these companies have planned investments in solar energy as a part of their strategic growth mission. Details of some of the activities of selected PSUs are:

NTPC and BHEL in the lead: With a power generation capacity of around 30 GW, NTPC is India's largest power utility. It is leading the way by planning large solar capacities on its own. NTPC has decided to add around 301 MW of solar power by March 2014. The other public sector giant BHEL has strong capabilities in the field of manufacturing electricity generation and transmission equipment. Extending these capabilities in the field of solar power generation is a natural diversification by following the joint venture (JV) route with various other PSUs like HPCL, BEL and IOC to build solar equipment and power plants in the country. It is understood that BHEL has won contracts for setting up three ecofriendly grid connected solar power plants with a cumulative capacity of 6 MW on a turnkey basis for Indiabulls. These orders are a part of the JNNSM, under which the government plans to generate 20,000 MW of solar power by 2020.

BHEL is already executing a separate turnkey contract for setting up ecofriendly, grid interactive solar power plants of 3 MW capacity in Raichur district of north Karnataka



Solar cooker at Aditya Solar Shop, Lucknow, Uttar Pradesh

Solar power panel in Jharkhand

Street lighting in Uttar Pradesh

for Karnataka Power Corporation Limited (KPCL).

Indian Oil Corporation (IOC): Flagship refiner-marketer IOC is setting up a grid linked solar power plant worth about Rs 100 crore at Barmer in Rajasthan, even as the state-run firm sharpens its focus on non conventional energy sources in an attempt to supplement fossil fuels earnings with carbon credits and moves towards a green future. It has been further gathered that IOC will set up the plant as a JV with BHEL. The plant will be set up on a piece of land belonging to the oil company's marketing division, while BHEL will supply the panels and other paraphernalia. Most of the electricity generated from the plant will be sold to the general grid, while some quantity may be used for captive use. IOC already has two pilot solar charging stations commissioned in Uttar Pradesh and Orissa. IOC further plans to set up solar power panels and power plants at its over 18,100 retail outlets across the country at a cost of Rs 500 crore. IOC wants to be an aggressive participant in the JNSSM and has created a new project division called Renewable Energy and Sustainable Development. Headed by S K Sarangi, the division would take up projects on renewable energy. Modalities of such projects are being worked out at present. At its retail outlets, on the other hand, the company plans to set up solar power panels of around 30 kW each on a pilot basis to meet the power consumption needs of the outlets.

ONGC: Although, ONGC happens to be Asia's biggest oil and gas exploration company, it is also exploring avenues to wrench a share out of the solar power sector. ONGC is stated to be in touch with major foreign solar energy companies to tap the solar power sector in a big way.

BPCL: BPCL has signed a MoU with the Punjab Energy Development Agency (PEDA) to set up a power plant on a build, operate and own (BOO) basis. The plant is to be set up at Lalru in Mohali at an approximate cost of Rs 22-22.5 crore, within the next 8-10 months. BHEL and HPCL are stated to have been working out the modalities to form a new JV company with equal equity participation for setting up a series of solar PV based power plants across the country. It is understood that the modalities of the JV arrangement are being worked out to begin with the development of a 25

The combined efforts of the PSUs are poised to bring a win-win situation for themselves and the JNNSM to usher in an era of solar power in India in a big way.

Parabolic solar cooker

MW capacity solar power project costing Rs 350 crore by 2012. The two companies, as is gathered, plan to scale up their solar power capacity plans to 100 MW by 2015 and to 1000 MW by 2020.

BEL: A premier electronic manufacturing company, BEL is planning a major investment in the solar energy space in a tie up with BHEL. BEL is in the process of setting up a greenfield facility to produce 2,500 tonnes of polycrystalline silicon (also known as polysilicon), the main raw material for making solar panels, at an investment of Rs 1500 crore. This translates into 250 MW of solar energy.

Summary comments

It may be seen from above that the combined efforts of the PSUs are poised to bring a win-win situation for themselves and the JNNSM to usher in an era of solar power in India in a big way. The PSUs will continue to play a pivotal role by upscaling the use of solar energy as their corporate strategic mission and social responsibility towards sustainable development, at the same time augmenting the government's mission of climate change mitigation through achieving the Misson's targets. Focus on adhering to the target should never be altered, to ensure the steady progress towards the ultimate goals of JNNSM.

The author is General Manager, Telecom, Power Grid Corporation India, New Delhi.

Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. Akshay Urja is an attempt to fulfil this need through the dissemination of 20,000 copies in India and abroad. The magazine publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photographs should be provided in high resolution files on a CD or through email. Akshay Urja will pay a suitable honorarium to the authors for each published article of 1500 words and above. The publication material in two copies, along with a soft copy on CD/DVD/e-mail may be sent to

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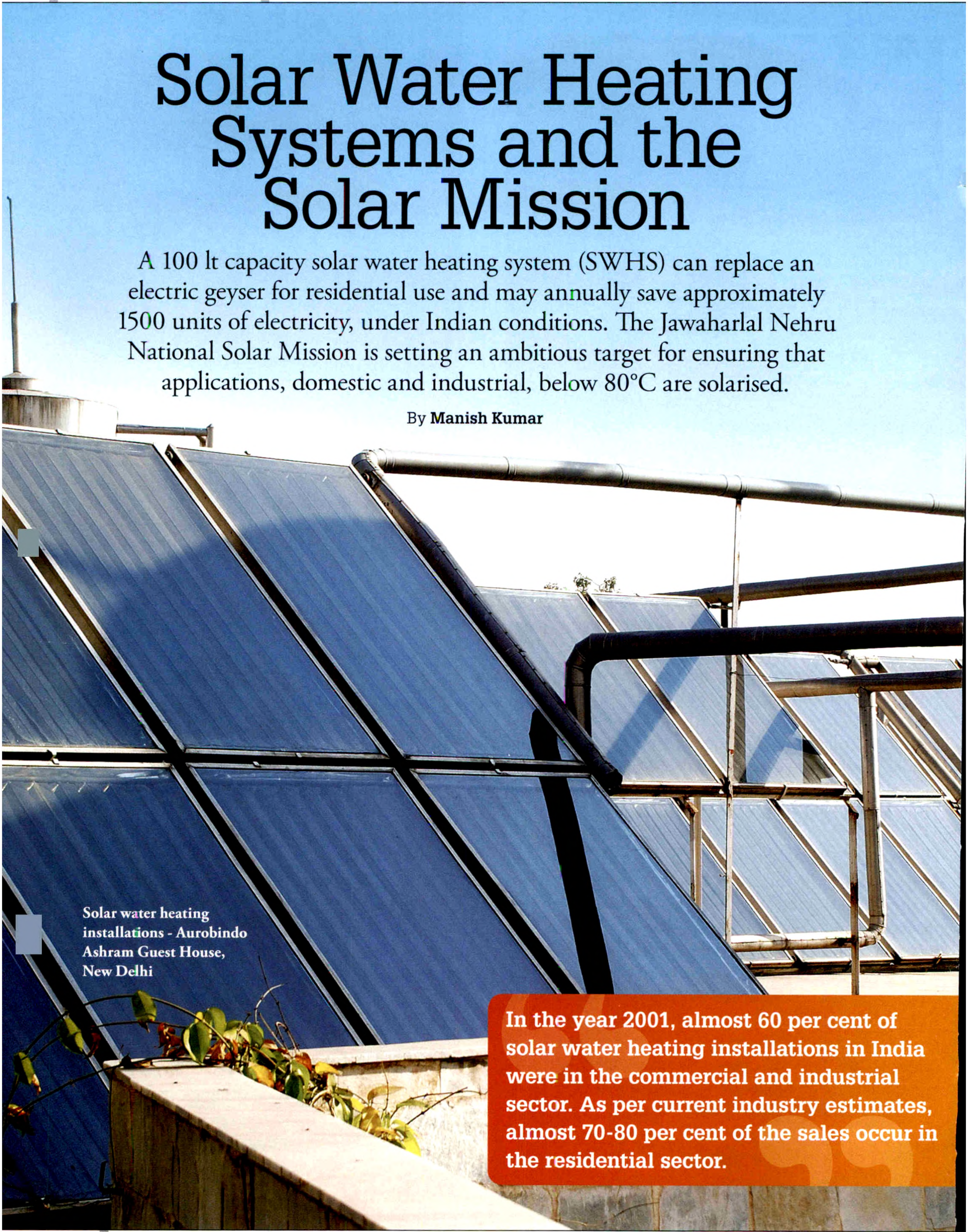
Solar Water Heating Systems and the Solar Mission

A 100 lt capacity solar water heating system (SWHS) can replace an electric geyser for residential use and may annually save approximately 1500 units of electricity, under Indian conditions. The Jawaharlal Nehru National Solar Mission is setting an ambitious target for ensuring that applications, domestic and industrial, below 80°C are solarised.

By **Manish Kumar**



Solar water heating installations - Aurobindo Ashram Guest House, New Delhi

> **In the year 2001, almost 60 per cent of solar water heating installations in India were in the commercial and industrial sector. As per current industry estimates, almost 70-80 per cent of the sales occur in the residential sector.**

Solar energy, being abundant and widespread in its availability, is one of the most attractive sources of energy in India. Tapping this energy will not only help in bridging the gap between demand and supply of electricity but also save money in the long run. A 100 lt capacity SWHS can replace an electric geyser for residential use and may annually save approximately 1500 units of electricity, under Indian conditions. It has also been estimated that a 100 litre per day (lpd) system (2 sq m of collector area) installed in an industry can save close to 140 lt of diesel in a year. Based on the above (100 lpd system saves 1500 units of electricity), it is estimated that in generating the same amount of electricity from a coal based power plant, 1.5 tonnes of carbon dioxide would be released into the atmosphere annually. Therefore, one million SWHS installed in homes can result in a reduction of 1.5 million tonnes of carbon dioxide emissions into the atmosphere.

SWHS and the Solar Mission

The immediate aim of the Jawaharlal Nehru National Solar Mission (JNNSM) is to focus on setting up an enabling environment for solar technology penetration in the country both at the centralised and decentralised level.

Some targets of the Solar Mission with regard to SWHS are:

- To create favourable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.
- To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022.

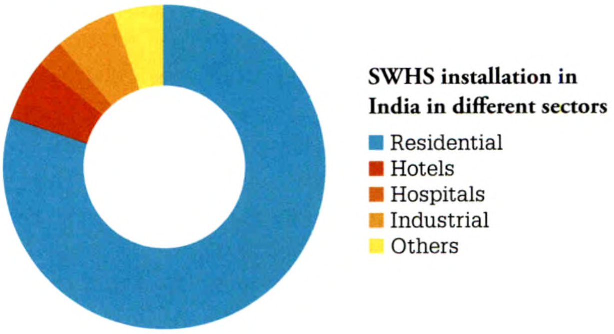
The Solar Mission in its first two phases will promote solar heating systems, which are already using proven technology and are commercially viable. It is setting an ambitious target for ensuring that applications, domestic and industrial, below 80°C are solarised. The key strategy would be to make necessary policy changes to meet this objective step wise as follows:

- Firstly, making solar heaters mandatory, through building bye laws and incorporating it in the National Building Code;
- Secondly, ensuring the introduction of effective mechanisms for certification and rating of manufacturers of solar thermal applications;
- Thirdly, facilitating measurement and promotion of these individual devices through local agencies and power utilities; and
- Fourthly, supporting the upgradation of technologies and manufacturing capacities through soft loans, to achieve higher efficiencies and further cost reduction.

In 2001, almost 60 per cent of solar water heating installations in India were in the commercial and industrial sector. As per current industry estimates, almost 70-80 per cent of the SWHS sales occur in the residential sector.

So, the residential sector has overtaken the commercial and industrial sectors and has become the main driver for growth of SWHS in India. Almost 60 per cent of these households are located in Maharashtra and Karnataka alone. More than 95 per cent of these households are located in the urban areas.

In Maharashtra, SWHS totalling a capacity of around 35 lakh lpd have been installed. Loans up to 85 per cent of the cost of a Bureau of Indian Standards (BIS) approved SWHS are available from nationalised and cooperative banks. The rate of interest for these loans is 2 per cent for individuals, 3 per cent for non profit organisations and 5 per cent for profit



SWHS installation in India in different sectors

Indian scenario of solar water heating collector area	
Techno economic potential	40 million sq m
National Solar Mission goal	20 million sq m by 2022
	7 million sq m by 2013
Demand projection	18.7 million sq m by 2022
	5.4 million sq m by 2013
Cumulative achievement	3.52 million sq m up to 31 March 2010
Preproject baseline	2.55 million sq m as on 30 September 2008

Solar water heating system at Sunbeam Hotel, Chandigarh

making organisations. The loan repayment period is 5 years - as arranged by the Ministry of New and Renewable Energy (MNRE) with the banks. The MNRE plans to include more nationalised banks for such loan facilities in the future. In Maharashtra there are eight manufacturers who have the BIS certification for solar flat plate collectors (FPCs). In addition, Indian Renewable Energy Development Agency Limited (IREDA), New Delhi, is also extending soft loans to end users under certain terms and conditions.

If a loan is not availed, then a central subsidy of Rs 2,200 per collector for non profit institutes and Rs 1650 per collector for profit making institutes is available.

In Karnataka also soft loans are available for installation of heating systems under the MNRE's SWHS scheme. The rate of interest for these loans is 2 per cent for domestic, 3 per cent for institutional and 5 per cent for commercial use.

Capital subsidy equivalent to upfront interest subsidy has been introduced to registered institutions and registered commercial establishments that do not avail soft loans. A capital subsidy of Rs 1100 per sq m of collector area will be available to registered institutions and that of Rs 825 per sq m to registered commercial establishments.

The Bangalore Mahanagara Palike vide bye law number 29 has issued an Order making the usage of solar water heaters mandatory for buildings having 200 sq m of floor area or 400 sq m of site area and 500 lpd for apartments having 5 units. To encourage the use of solar water heaters, which help in reduction of peak loads, all electricity supply companies in Karnataka are providing a rebate of 50 p per unit with a maximum limit of Rs 50 per installation. So far, around 5 lakh collectors have been installed in the State. In some states, rebates of up to Rs 100 are being provided by the government in the monthly electricity bills for 100 lpd.

Recent policy of Indian Government regarding SWHS

The MNRE has approved financing by banks for FPCs and evacuated tube collector (ETCs) based

SWHS manufactured/installed by the BIS approved manufacturers, with capital subsidy and refinance support from the National Bank for Agriculture and Rural Development (NABARD).

Capital subsidy and refinance would be made available from time to time as per the specifications of MNRE/ IREDA. For ETCs based SWHS, capital subsidy will be limited to Rs 3,000 per sq m of collector area while for FPCs with liquid as the working fluid, the subsidy will be limited to Rs 3,300 per sq m. For FPCs with air as the working fluid, the capital subsidy is limited to Rs 2,400 per sq m of collector area.

The eligible capital subsidy would be released upfront to the banks on receipt of the drawal application format after sanction of the loan by the bank. However, from the financing banks the capital subsidy component would be released to the suppliers on behalf of the borrower only after satisfactory installation and commissioning of the system. Though, in order to enable the borrowers to access the benefit of the capital subsidy, the loan repayment period would have a minimum lock-in period of three years from the date of disbursement of the first instalment of the loan.

The borrowers are required to bring in 20 per cent of the cost of the project as the margin money for accessing credit facilities from banks to acquire the assets. The loans to cover the balance after reducing the eligible capital subsidy, would be extended with a repayment period not exceeding 5 years and would carry an interest rate of 5 per cent per annum. No interest will, however, be charged by the financing banks on the capital subsidy component.

The attractiveness of SWHS

It makes economic sense to think beyond the initial purchase price and consider the lifetime energy costs. One would spend much more on electricity over an electric geyser's lifetime when compared to the initial price of a SWHS and its maintenance over its expected lifetime of 15-20 years. Thus the overall cost of SWHS from cradle to grave would be a small fraction compared to that of an electric geyser, not to mention the invaluable environmental benefits of a SWHS.

However, immense care should be taken in choosing a solar water heater, just as one would in the purchase of any major appliance. A solar water heater is a long term investment that will save money and energy for many years. Like other renewable energy systems, solar water heaters minimise the environmental impact yet allow one to enjoy a comfortable, modern lifestyle. In addition, they provide insurance against energy price increase, help reduce dependence on imported oil, and are investments in everyone's future.

> **A solar water heater is a long term investment that will save money and energy for many years.**

The use of 1000 SWHSs of 100 lt capacity (2,000 sq m of collector area) each can contribute to a peak load shaving of 1 MW. Also, a SWHS of 100 lt capacity can prevent emission of 1.5 tonnes of carbon dioxide per year.

The challenges and way forward

The main challenges for achieving a 15 per cent compound annual growth rate (CAGR) in SWHS collector area from now up to the targeted values in 2022 are:

- Market barriers concerning high initial cost of the SWHS and inefficient supply chain from manufacturing to installation at customer's premises, which thwarts adoption of SWHS even when the scheme is supported by soft loans, capital subsidies and electricity rebates.
- Technological barriers concerning higher efficiency SWHS in which the issues of space constraint, maintenance and quality of components are overcome by enabling more energy conversion per unit area of solar collector.
- Administrative barriers like lack of enforcement and monitoring of relevant building bye laws wherever existing and lack of one stop solutions for SWHS, which result in good policies not producing desired results.
- Lack of enabling mechanisms such as markets offering customised solutions for dwelling/institutional/ commercial units like multistoried apartments/business process outsourcing units (BPOs)/food courts etc.
- Inadequate mass awareness programmes.

In economic parlance, solar energy and electricity, and extending the relationship further, solar energy based products and electricity based products should be perfect substitutes. When the price of electricity goes up, the demand for solar energy should also go up. The price of grid connected and off grid electricity is going up but it is not translating into increased demand for SWHS. Therefore, polices should be geared towards removing barriers and pushing SWHS to a considerable set of energy consumers so that the tangible and intangible benefits of SWHS can accrue to individuals and the nation. ✪

The author is Joint Director and Energy-Auditor, Petroleum Conservation Research Association, New Delhi

Web/Book Alert

Website

Getting the REC

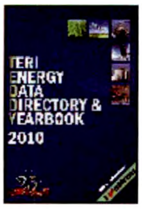
www.recregistryindia.in

The web site, launched on 18 November 2010 provides a step by step guide to Renewable Energy Certificates (REC). The Electricity Act, 2003, the policies framed under the Act, as also the National Action Plan on Climate Change (NAPCC) provide for a roadmap for increasing the share of renewables in the total generation capacity in the country. It is in this context that REC assumes significance. This concept seeks to address the mismatch between availability of RE sources and the requirement of the obligated entities to meet their renewable purchase obligation. Central Electricity Regulatory Commission (CERC) has notified regulation on REC in fulfilment of its mandate to promote renewable sources of energy and development of the market in electricity. The framework of REC is expected to give a push to RE capacity addition in the country.

Financing RE

www.indiamicrofinance.com

The website publishes specialised news and information on the emerging microfinance sector with an emphasis on developments in the Indian economy especially with regard to investments in the renewable sector. Indiamicrofinance.com seeks to highlight success stories and interviews on microfinance with the goal of encouraging a rational growth of the industry. It also provides reports and statistics on emerging opportunities in the Indian economy.



TERI Energy Data Directory (TEDDY) 2010

Author: **TERI**
Hardcover: 464 pages
Cover price: USD 129 (Year: 2011)
ISBN: 9788179933930

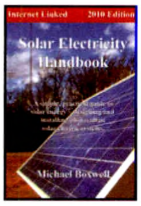
Migration and Remittances Factbook 2011

by **World Bank**
Paperback: 256 pages
Cover price: USD 39.95
Publisher: World Bank (November 2010)
ISBN: 978-0-8213-8218-9

Mainstreaming Building Energy Efficiency Codes in Developing Countries

Global Experiences and Lessons from Early Adopters

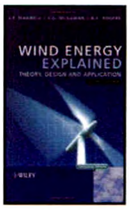
by **Feng Liu, Anke S Meyer, John F Hogan**
Paperback: 224 pages
Cover price: USD 25
Publisher: World Bank
(October 2010)
ISBN: 978-0-8213-8534-0



2011 Solar Electricity Handbook

A simple, practical guide to solar energy - designing and installing photovoltaic solar electric systems.

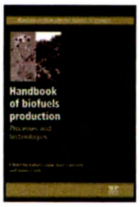
by **Michael Boxwell**
Paperback: 187 pages
USD 14.99
Publisher: Greenstream Publishing
(February 2011)
ISBN: 978-1-907670-04-6



Wind Energy Explained:

Theory, Design And Application, 2nd Edition

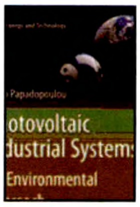
by **James F Manwell, Jon G McGowan, Anthony L Rogers**
Hardcover: 704 pages
Cover price: USD 100
Publisher: John Wiley and Sons
(February 2010)
ISBN: 978-0-470-01500-1



Handbook of Biofuels Production:

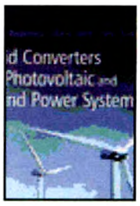
Processes and Technologies

Edited by **R Luque, J Campelo, J Clark**
Hardback: 688 pages
Cover price: USD 280
Publisher: Woodhead Publishing Limited
(November 2010)
ISBN 1 84569 679 4
ISBN-13: 978 1 84569 679 5



Photovoltaic Industrial Systems An Environmental Approach

by **Elena Papadopoulou**
Hardcover: 130 pages
Cover price: 99.95 EURO
Publisher: Springer (2011)
ISBN: 978-3-642-16300-5



Grid Converters for Photovoltaic and Wind Power Systems

by **Remus Teodorescu, Marco Liserre, Pedro Rodriguez**
Hardcover: 416 pages
Cover price: USD 160
Publisher: Wiley
(March 2011)
ISBN: 978-0-470-05751-3

Inputs from various websites

National

1 to 2 March 2011	International Symposium on Energy Materials: Opportunities and Challenges (ISEM-2011) Place: Kolkata Organised by: Central Glass and Ceramic Research Institute (CGCRI) Contact: 91 (33) 2473 5829 Website: www.cgcri.res.in
10 to 11 March 2011	RenewCon Solar India 2011 Place: Mumbai Organised by: The Energy Business Conferences Contact: 91 (22) 4046 1466 Website: www.renewconsolar-india.com
18 March 2011	National Conference on Electrical Systems and Renewable Energy 2011 (NESR'11) Place: Tiruchirappalli Organised by: Department of Electrical and Electronics Engineering, Anna University of Technology, Tiruchirappalli Contact: 91 (431) 240 7970 Website: www.tau.edu.in
25 March 2011	National Workshop on Solar Photovoltaic Component, System and Design Place: Noida Organised by: ITS Engineering College, Greater Noida Contact: 91 (120) 233 1000, 91 (0) 991 096 2760 Website: www.itsecgn.edu.in
21 to 23 April 2011	World Renewable Energy Technology Congress & Expo'2011 Place: New Delhi Organised by: World Renewable Energy Technology Congress & Expo'2011 Contact: 91 (11) 2453 8318 Website: www.wretc.in

International

02 to 04 March 2011	World Sustainable Energy Days 2011 Place: Wels, Austria Organised by: OO Energiesparverband Contact: 43 (732) 77201 4380 Website: www.wsed.at
07 to 08 March 2011	Renewable Energy Development on Federal Lands Place: San Diego, California Organised by: Electric Utility Consultants, Inc. Contact: 11 (303) 770 8800 Website: www.euci.com
15 to 16 March 2011	Biomass Conference 2011 Place: Kuala Lumpur Malaysia Organised by: Asia Executive Programs Sdn Bhd Contact: 60 (3) 6203 2009 Website: www.aep.com.my
21 to 24 March 2011	Solar Power Finance and Investment Summit 2011 Place: San Diego, California Organised by: Information Forecast Inc. Contact: 11 (818) 888 4444 Website: www.infocastinc.com
23 to 24 March 2011	Offshore Wind Power Development Asia 2011 Place: Shanghai, China Organised by: EnergyIQ, International Quality & Productivity Centre Contact: 65 6722 9388 Website: www.iqpc.com
24 to 25 March 2011	Renewable Energy and Grid Integration China Summit 2011 Place: Beijing, China Organised by: The Oppland Corporation Contact: 86 (21) 5058 9600 Website: www.opplandcorp.com
25 to 27 March 2011	2011 International Conference on Future Environment and Energy (ICFEE 2011) Place: Sanya, China Organised by: Asia-Pacific Chemical, Biological & Environmental Engineering Society (APCBEES) Contact: 852 3069 7153 Website: www.icfee.org
31 March to 2 April 2011	Sustainable Environment Technologies-SET2011 Place: Los Angeles, California Organised by: Sustainable Environment Technologies Contact: 11 (213) 483 8182 Website: http://sustainableindustries.com

Renewable Energy at a Glance

Cumulative deployment under various renewable energy schemes/programmes in India

Renewable energy Programmes/systems	Cumulative achievements (as on 31 December 2010)
1. Power from renewables	
A. Grid interactive renewable power	**In MW**
Wind power	13065.78
Small hydro power	2850.25
Biomass power (agro-wastes/residues)	979.10
Bagasse cogeneration	1494.53
Waste to power	72.46
Solar power	17.82
Sub total (A)	**18479.94**
B. Off grid/distributed renewable power(including captive/CHP plants)	
Biomass power/Cogeneration (Non-Bagasse)	267.08
Biomass gasifiers	128.16
U&I waste-to-energy	60.78
Rural waste-to-energy	0.45
Solar PV power plants and street lights(>1kW)	2.39
Aero-generators/hybrid systems	1.07
Sub total (B)	**459.93**
Total (A+B)	**18939.87**
2. Remote Village Electrification (villages/hamlets provided with electricity/lighting systems)	**6446/1587**
3. Decentralised energy systems	
Family type biogas plants (in lakh)	43.10
SPV street lighting system (in nos.)	1,22,339
SPV home lighting system (in nos.)	6,69,400
SPV lanterns (in nos.)	8,13,380
SPV pumps (in nos.)	7495
SPV water heating-collector area (in million sq m)	3.53
Solar cookers (in lakh)	6.64
Wind pumps (in nos.)	1420

MW = Megawatt; Sq m = Square metre

सत्यमेव जयते
stry of New and
ewable Energy
vernment of India

Volume 4 ■ Issue 5 ■ April 2011

Renewable Energy

Akshay Urja

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Congress and Expo held a
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from 21st to 23rd Apri
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by 325 delegates
dignitaries and speaker
from 33 countries

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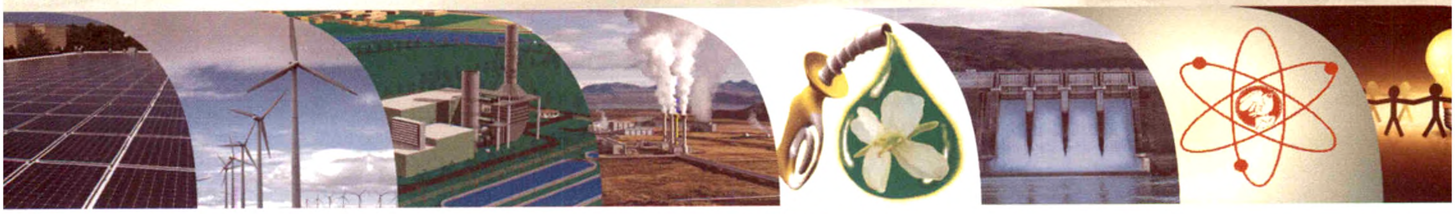

WRETC Secretariat
F1-F2, Pankaj Grand Plaza, CSC Complex, Mayur Vihar-I, Delhi-110091, India • Tel: +91 11 24538318. Fax: +91 11 43019379

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Renewable Energy
Akshay Urja

Volume 4 ▪ Issue 5
April 2011

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India
(Published in English and Hindi)

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Produced by
Iris Publication Pvt. Ltd.
111/9 KG, Aruna Asaf Ali Marg,
Vasant Kunj, New Delhi -110 070
Telefax. +91 11 2612 2789, 2689 2275
E-mail: ipplimited@yahoo.co.in
Web: www.geographyandyou.com

Publisher and Printer
Ministry of New and Renewable Energy, New Delhi

Cover Photos: GRIHA rated buildings- IIT, Kanpur (T) Unilever, Mumbai, (BL), Fortis, Delhi, (BC) and Suzlon, Pune (BR).

Disclaimer: The views expressed by authors

From the Editor's Desk

Dear Readers,

At present India is experiencing heavy construction activities in all spheres, which in turn is leading to an increase in the demand for energy. This is due to rapidly growing urbanisation and the increasing affordability of the people. Buildings are major consumers of energy in their construction, operation and maintenance. Globally, about 40 per cent of energy consumption is estimated to be in the building sector.

A Green Building depletes the natural resources to a minimum during its construction and operation, minimises the demand on fossil fuel based energy, maximises the recycle, reuse, renewable energy and energy efficient devices and appliances. It utilises energy efficient building materials, besides, it takes care of water conservation, waste management, energy conservation etc. Green Buildings promote the use of renewable energy systems i.e. solar water heating systems, rooftop PV system, waste recycling for energy generation etc.

Building rating systems are a popular tool for measurement of the greenness of a building under certain guidelines. At present two green building rating systems are in vogue in our country. One is LEED-India which gives buildings ratings of Platinum, Gold, Silver or LEED-certified and the other is the GRIHA rating system which rates buildings on a 1 to 5 star scale, with 5 stars signifying the most energy efficient green buildings.

CPWD, the largest construction Department of the Government of India, has decided to have their future constructions GRIHA rated. Although the government is making efforts to promote Green Building construction in the country, it may not be enough. The support of the private builders and individual house owners is crucial. There is utmost need that all buildings constructed in the future should be green buildings only.

This issue of Akshay Urja has been put together around the theme of Green Buildings. I am sure it will benefit and sensitize you all towards the importance of Green Building construction. Well experienced Green Building and sustainable construction professionals have contributed their wealth of ideas for the issue. Please send your opinions and reactions to enable us to make Akshay Urja a more informative and meaningful publication.

अक्षय ऊर्जा से देश विकास

ARUN K TRIPATHI
<aktripathi@nic.in>

Published, printed and edited for and on behalf of the Ministry of New and Renewable Energy, Government of India, from B-14, CGO Complex, Lodhi Road, New Delhi, by Dr Arun Kumar Tripathi. Printed at Aravali Printers & Publishers (P) Ltd. W-30, Okhla

Letters to the Editor

I am very much interested in getting the Akshay Urja newsletter as it is very educative. I got a copy of the last issue of the magazine from my friend and it was a great help to me to make projects on the subject of solar and other non conventional energy sources. The project information which I got from this magazine was highly appreciated by others. I therefore request you to regularly send a copy of the bimonthly newsletter/annual reports to me.

Khyaati Mittal,
Mayur Vihar, Delhi

I came across the Akshay Urja newsletter and found it very interesting and informative. I would like to receive the newsletter regularly, please let me know how I can subscribe to it.

R A K S Ramalingam,
Erode, Tamil Nadu

I would like to receive the Akshay Urja newsletter as I have found it to be very relevant and informative.

Rambabu Kumar
rambabu9576@gmail.com

Please include the name of our company in the subscription/mailing list of the esteemed publication - Akshay Urja newsletter. We would like to start receiving the newsletter immediately and would appreciate if we could get copies of the last two issues of the newsletter as well.

Director, World Solar Power Private Ltd, solar@worldsolar.in

Our office in Assam is dedicated to the development of one remote district in an extreme corner of the north eastern part of the country. The Akshay Urja newsletter will help us to learn about and popularise new and non renewable energy technology among the large undeveloped rural population of the district. We therefore request you to kindly send us a copy of the newsletter regularly.

L D M, United Bank of India
Tinsukia District, Assam

I am an engineer and have been dedicated to the cause of renewable energy for the last many years. Currently I am involved in establishing biomass briquette plants and conversion of industrial boilers into briquette ones. I am a life member of the Millennium Institute of Energy and Environment. I would like an annual subscription to the Akshay Urja newsletter and kindly request you to do the needful for the same.

Bijan Bhattacharjee
bhattacharjee_bijan@yahoo.co.in

Thank you very much for sending me Volume 4, Issue 2 & 3, December 2010 of the Akshay Urja newsletter. I have found this bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India very pertinent as it gives a lot of information regarding renewable energy. Also, I recently bought your book 'Multiple choice Questions on Energy' from TERI Press and would like to congratulate you on writing such an educative and good book. I look forward to receiving the Akshay Urja newsletter regularly.

Er Anirudra Prasad Yadav, MIE
Kathmandu, Nepal

निवेदन है कि हमारे द्वारा ग्रामीणों को समर्पित पत्रिका ग्राम समृद्धि का प्रकाशन किया जा रहा है। पत्रिका में ग्रामीणों के लिए बनायी जा रही कल्याणकारी योजनाओं का विस्तृत विवरण और उससे संबंधित आवेदन पत्रों का प्रकाशन किया जा रहा है। कृपया पत्रिका अक्षय ऊर्जा (हिन्दी संस्करण) हमारे पत्र में दिए गए पते पर भेजने की कृपा करें। यदि संभव हो तो अक्षय ऊर्जा के हिन्दी संस्करण के पिछले अंक भी भेजने की कृपा करें।

डॉ. संदीप नारद
सम्पादक, ग्राम समृद्धि

आपके कार्यालय द्वारा प्रकाशित 'अक्षय ऊर्जा' पत्रिका को हमें भेजने का कष्ट करें, और इस पत्रिका का प्रत्येक अंक भेजे। इसके लिए मैं सदा आपका आभारी रहूंगा।

असमी कुमार खां
बिरसानगर जमशेदपुर, झारखंड

आपकी पत्रिका अक्षय ऊर्जा पढ़ने को मिली, पढ़कर बड़ी खुशी हुई कि पत्रिका में प्राकृतिक संसाधन को बचाने के बारे में तथा ऊर्जा के नये स्रोत काम में लाने के बारे में बताया गया है। इस पत्रिका के आने से सौर ऊर्जा, पवन ऊर्जा एवं जैविक ऊर्जा के क्षेत्र में मंत्रालय द्वारा नए–नए शोध अध्ययन, उपाय एवं मिलने वाले स्थान और ऊर्जा के बारे में होने वाले नियमों, शर्तों आदि के बारे में पूरी जानकारी मिलेगी और उसका लाभ हमारे सतना जिले के सभी जनवासियों को होगा।

दीपक कुमार बुधौलिया
सतना, मध्य प्रदेश

Dear Reader, Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvements in terms of content and presentation. **Editor: Akshay Urja**

Contents April 2011

RE News

National 4-7
● Solar energy based telecom towers ● JV planned in Russia for Solar PV cells ● RRB Energy wind electric generators ● Su-Kam Power to make solar invertors ● Bio waste gasifier ● Zero Energy Building ● Business meet on ETC based solar water heating system at SPRERI ● IFC and GERMI pact for solar power project ● Solar energy to power Gurgaon by 2012 ● First floating solar energy plant in India ● Accolade: Mr S K Shukla shortlisted for 'Zayed Future Energy Prize' ● Moventas to set up base in India ● World Bank keen to partner India ● Asian Green City Index rankings ● Nakoda commences wind power plant ● India to cut greenhouse gas emissions by 2020 ● Trading begins for Renewable Energy credits ● Solar Mission projects could see ban on imported equipment ● Penalties collected from discoms to help promote wind energy ● IREDA and MNRE sign MoU ● District gets its first solar biometric ATM

International 8-9
● World Green Building week
● Willing to pay more for green space
● Advanced thin film solar panels
● Solar ambassadors share stories
● Cheaper, more efficient solar cells
● Solar installations on water ● Green Building, Renewable Energy Directories launched ● Largest cogeneration power plant in Mexico ● Indonesia begins embracing wind power ● GE acquires rights to build tall wind towers
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The environment friendly construction techniques and mechanical systems used in the building cost no more than their conventional energy intensive counterparts.

Improvements in energy efficiency are the key to unlocking massive carbon reduction potential. The industry still has some way to go before it can impact the planet.

There was a realisation that simply making green buildings that are efficient users of water, energy and materials would not create a green campus.

Accolade: Mr S K Shukla shortlisted for 'Zayed Future Energy Prize'

The Zayed Future Energy Prize is a prestigious and internationally recognised award for innovation, performance and leadership in sustainable and renewable energy projects. Four Indians were shortlisted for the prize through a rigorous selection process from 391 submissions - among them was Mr Shailendra Shukla, Director, Chhattisgarh Renewable Energy Development Agency (CREDA). Mr Shailendra Shukla has been promoting green technologies for the last two decades. He has been instrumental in establishing CREDA for developing green technologies in the newly formed and tribal inhabited state of Chhattisgarh.

Energy Next, January 2011

Asian Green City Index rankings

Mumbai, Kolkata and Bangalore have been ranked below average, while Delhi is an average performer in the Asian Green City Index that termed Singapore as the greenest city in the continent. The research, commissioned by German engineering major Siemens and Economist Intelligence Unit categorises Asian cities with respect to the environmental performance in eight categories: energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality and environmental governance.

www.thehindubusinessline.com, 15 February 2011

Moventas to set up base in India

Finnish company Moventas, one of the largest manufacturers of wind turbine gears in the world, plans to harness India's economic potential by setting up a base in Chennai. The name of the Indian entity will be Moventas India Private Limited. "The location of our company will be at Chennai because most of the windmill customers are based in southern India", said Olli Valimaki, senior vice president of Moventas. "So far we have been serving our Indian clients from Finland and they have been requesting us to come to India. Moreover, this is the only way to relate to local people. The Indian market is growing very fast".

www.sify.com, 26 March 2011

World Bank keen to partner India

The World Bank is open to partnering the Indian Government for developing the renewable energy sector. The Government has set an ambitious target of installing at least 40 GW of additional capacity of renewable energy in the next 10 years. India will not only have to meet targets set under the National Solar Mission, but double its wind capacity, quadruple its small hydropower power capacity, fully realise co-generation capacity, and increase biomass realisation by a factor of five to six. However, to achieve this target significant financial and regulatory barriers are required to be addressed, a World Bank report on 'Unleashing of the Potential of Renewable Energy in India' said. To achieve the target of 40 GW by 2022, the report suggests single window clearance for all renewable projects, promoting innovative approaches, a competitive bidding process, and providing long term funding options for producers.

www.thehindubusinessline.com, 11 February 2011

Nakoda commences wind power plant

Nakoda Ltd announced the commencement of its wind power plant at Jethana, Ratlam District, Madhya Pradesh. The plant has 7 turbines with a capacity of 750 kW each aggregating to an additional capacity of 5.25 MW. The company's post expansion capacity will be 12 MW. The project cost of Rs 32.92 crore is funded entirely from internal resources. Nakoda Limited has entered into a power purchase agreement (PPA) with Madhya Pradesh Electricity Board to supply around 112 lakh units per year at the rate of Rs 4.35 per unit for 25 years.

www.business-standard.com, 17 February 2011

India to cut greenhouse gas emissions by 2020

In addition to raising its energy efficiency by 20 per cent in five years, India has decided to meet climate change challenges by reducing its greenhouse gas emissions by 20 to 25 per cent (of 2005 level) by 2020, the Economic Survey (ES) for 2010-2011 has revealed. However, India is not sure of the resources required for achieving this domestic mitigation goal.

www.thestatesman.net, 27 February 2011

Trading begins for Renewable Energy credits

India's largest power exchange began trading the country's first renewable energy credits, saying the new commodity may develop a liquid market by the year end. The first trading session on the Indian Energy Exchange received 11 buy bids seeking certificates from solar plants and 125 bids for certificates for renewable energy from wind, hydropower or biomass projects, according to Jayant Deo, chief executive of the exchange.

www.bloomberg.com, 23 February 2011

Solar Mission projects could see ban on imported equipment

The government is considering a ban or further restriction on import of equipment for projects under the National Solar Mission. The move will benefit domestic solar equipment suppliers, but project developers say it could prevent the government from achieving its target of 20000 MW of solar power generation capacity by 2022, since a full local-content clause could slow deployment of new technologies. In the face of competition from foreign players, domestic solar equipment makers were able to corner only 30 per cent of projects, totalling 704 MW, in the first round of bidding under the National Solar Mission.

The Economic Times, 4 March 2011

Penalties collected from discoms to help promote wind energy

The Indian government will create a corpus out of penalties paid by state run power distribution utilities to promote wind energy projects of 10 MW or more capacity. The Central Electricity Regulatory Commission (CERC) has approved the fund, its chairman Pramod Deo said. The renewable regulatory fund would bear charges imposed on states hosting wind projects that fail to comply with their energy supply commitments to the electricity grid, he said.

The Economic Times, 14 March 2011

IREDA and MNRE sign MoU

Indian Renewable Energy Development Agency Ltd (IREDA), a Government of India enterprise has entered into a memorandum of understanding (MoU) with the Ministry of New and Renewable Energy (MNRE) for the year 2011-12 at a brief function held at New Delhi. Shri Deepak Gupta, Secretary, MNRE and Shri Debashish Majumdar, CMD, IREDA signed the document on 24 March 2011 in the presence of Directors, IREDA and senior officials of MNRE.

www.mnre.gov.in, 24 March 2011

District gets its first solar biometric ATM

The Union bank of India (UBI) unveiled the region's first solar powered, voice enabled biometric rural ATM at Ghawaddi village in Ludhiana District, Punjab. The product of a collaboration between Vortex and Indian Institute of Technology (IIT), Chennai, the ATM works on solar power, has low power consumption and can support biometric and PIN based transactions, according to bank officials. "These features make it ideal for the rural environment where power supply is a critical factor and literacy levels are low," said S S Mundra, Executive Director of UBI.

www.indianexpress.com, 27 March 2011

World Green Building week

The World Green Building Week 2011 will be celebrated from 19-23 September 2011. World Green Building Week is celebrated annually to draw attention to the role of Green Buildings in the creation of healthier, more sustainable communities. Green Building Councils and their members from around the world will be marking the week with events and celebrations reflecting the diversity of their cultures and industries.

www.worldgbc.org, 15 March 2011

Willing to pay more for green space

In a survey by real estate services firm Jones Lang LaSalle and property professionals' association CoreNet Global, the proportion of respondents willing to pay more for 'green leased space' was 50 per cent, in 2009 this figure was 37 per cent. The poll also found that 92 per cent of respondents consider sustainability criteria in their location decisions. Another 23 per cent said they would pay more in rent if it were offset by lower energy costs.

www.environmentalleader.com, 10 February 2011

Solar ambassadors share stories

Clean Energy Logistics Lab in technology partnership with Caspio, USA established a grassroots online community (http://www.FindSolarPro.com) of solar photovoltaic (PV) enthusiasts to share personal experiences of going solar, plus information how their own solar PV panels and systems work. Known as Solar Ambassadors, members provide panel and system information, videos, and live system monitoring streams of their own energy generation and usage.

www.thestreet.com, 16 March 2011

Advanced thin film solar panels

Sunvalley Solar Inc. announced the promotion of the TW-TF series thin film product for the US market. The previous thin film modules required a larger surface area and expensive racking and BOS systems for installation. The new TW-TF series from Tianwei, which is being promoted by Sunvalley in the US, is a more advanced and efficient A-Si Thin film module. A lesser surface area is used and a lower installation cost is to be expected. The A-Si thin film module has a better performance rating in high temperatures and lower irradiance conditions than previous models. Not only is the performance on the A-Si thin film modules better, but the expense is much lower than the crystalline silicon PV modules.

www.sunvalleysolarinc.com, 16 February 2011

Cheaper, more efficient solar cells

Stanford researchers led by Professor of chemical engineering Stacey Bent have found that adding a single layer of organic molecules to a solar cell can increase its efficiency three fold and could lead to cheaper, more efficient solar panels. Their results were published online in ACS Nano on 7 February 2011.

www.sciencedaily.com, 21 February 2011

Solar installations on water

Most solar energy systems on the market today have two major weaknesses: they require vast land areas to be built and the costs related to solar cells fabrication and maintenance are high. A new technology - floating solar power plants - is about to overcome these challenges and many more. Developed by a Franco Israeli partnership, this innovative solar power technology introduces a new paradigm in energy production. The project team identified the almost untouched potential of solar installations on water. The water basins, on which the plants could be built are industrial water basins already in use for other purposes. The developers were able to reduce the costs linked to the implementation of the technology by reducing the quantity of solar cells used thanks to a sun energy concentration system based on mirrors and by a creative cooling system using the water on which the solar panels are floating.

www.sciencedaily.com, 27 February 2011

Green Building, Renewable Energy Directories launched

The Natural Resources Defense Council (NRDC) and Institute for Market Transformation (IMT) have launched a global library of building energy rating policies. BuildingRating.org aims to create a standard way of comparing the energy performance of buildings, by providing a searchable library of rating and disclosure information. Users of the website can search the energy performance policies of more than 100 countries and jurisdictions to learn how they are being implemented, what types of rating systems they are using to evaluate energy performance, and how policies are impacting markets.

www.environmentalleader.com, 8 March 2011

Largest cogeneration power plant in Mexico

The financing of México's largest cogeneration power plant - owned by GE Energy Financial Services and Abengoa - has been named Overall Latin American and Latin American Power Deal of the Year by Project Finance magazine. The magazine selected the financing for the 300 MW cogeneration power plant under construction in Tabasco, México, because it enabled construction of the first independently owned power plant to supply Méxican state oil company PEMEX.

www.worldofrenewables.com, 9 March 2011

Wind and solar energy growth

Wind and solar energy averaged 30 and 40 per cent growth, respectively, last year, according to a Clean Edge report Clean Energy Trends 2011. The report tracks the growth of renewable energy markets and looks at trends that will shape investment in wind, solar and biofuels for the coming years. The global market for solar photovoltaics (PV) has expanded from USD 2.5 billion in 2000 to USD 71.2 billion in 2010, representing a compound annual growth rate (CAGR) of 39.8 per cent, while wind power has expanded from a global market worth USD 4.5 billion in 2000 to more than USD 60.5 billion today, for a CAGR of 29.7 per cent.

www.motherearthnews.com, 14 March 2011

Indonesia begins embracing wind power

Indonesia, the world's fourth most populated nation, is about to begin developing wind energy. The country's first large scale wind turbines plant will be built in Sukabumi, West Java, later this year with a total capacity of 30 MW. The renewable energy division head Muhammad Sofyan, said that the Energy and Mineral Resources Ministry had approved the project and local energy firm Viron Energy was waiting for the ministry to issue an official permit to begin construction.

http://7thspace.com, 12 March 2011

GE acquires rights to build tall wind towers

A unit of General Electric - GE Power & Water has paid an undisclosed amount to Utah based Wind Tower Systems for intellectual property rights backing its Space Frame Tower technology, which enables the construction of taller wind turbine towers. The acquisition, along with access to transportation technology that allows standard flatbed truck to transport these tall towers, comes as the length of blades supporting next generation wind turbines are becoming longer and require taller towers.

http://uk.ibtimes.com, 14 February 2011

Solar thermal energy calculation

The International Energy Agency Solar Heating and Cooling Programme (IEA-SHC) and major solar thermal industry associations have agreed on a common calculation method to estimate the annual solar collector energy output in kWh. With this method, it will be simpler to estimate the impressive amount of energy produced by solar thermal systems worldwide and compare it with other (renewable) energy sources. The newly developed methodology introduces very simple formulas, using easily accessible information to estimate the respective annual solar collector output.

www.iea-shc.org, 16 March 2011

Building a Momentum

Green Buildings

Buildings are major consumers of energy in their different phases - construction, operation and maintenance. Globally about 40 per cent of energy consumption is estimated to be in the building sector. Hence, green buildings are the need of the hour to effect a reduction in energy consumption.

Arun K Tripathi

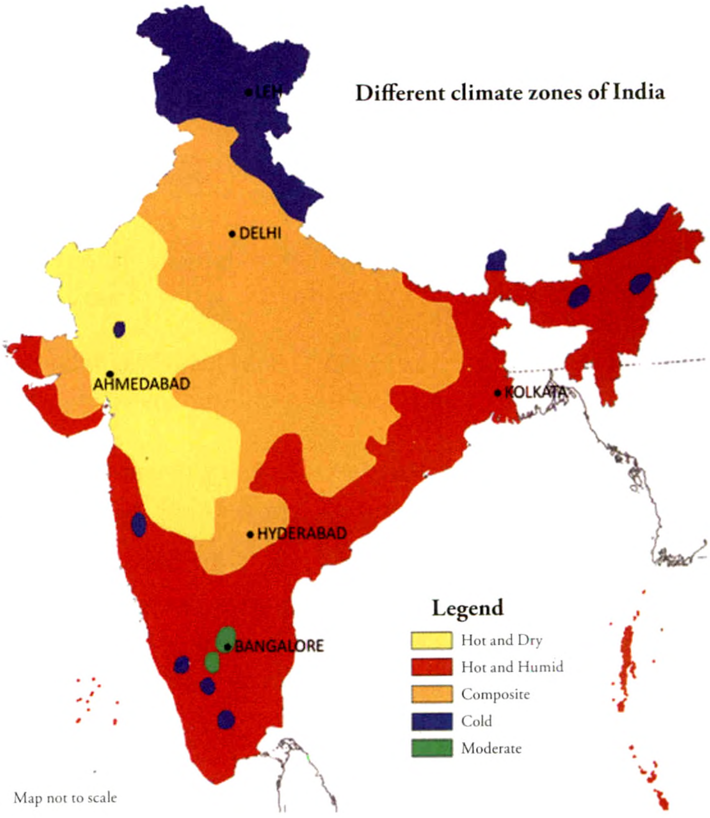
A green building is one which can function using an optimum amount of energy, consume less water, conserve natural resources, generate less waste and create spaces for healthy and comfortable living, as compared to conventional buildings. In other words, a green building minimises the demand on fossil fuel based energy and maximises usage of renewable energy along with the reuse and recycle of resources.

Green building design is a practical and climate conscious approach based on various factors - geographical location, prevailing climatic conditions, locally available and low embodied energy materials and design parameters relevant to the type of usage of the building. Such an approach ensures minimum harm to the environment while constructing and using the building. A study of the traditional building techniques in India clearly shows that the concept of green or sustainable buildings has existed in the country for a long time. These buildings were generally made of locally available materials like wood, mud and stone and dealt with the vagaries of weather without using large amounts of external energy to keep the inhabitants comfortable.

The need for green buildings

Modern buildings are major consumers of energy in their construction, operation and maintenance. At present India is experiencing heavy construction activities in all spheres - as a consequence the demand for energy is also increasing rapidly. This is partly due to the growing urbanisation and the increasing affordability of the people. However, the concept of clean and efficient development has also been gaining momentum and the Government of India is promoting green buildings as part of its strategy to mitigate fossil fuel based energy requirements and to meet the growing demand for energy through renewables and energy efficiency measures.

◀ **Centre for Environmental Science and Engineering, Indian Institute of Technology, Kanpur** GRIHA, 5 star rated
Select strategies adopted to reduce building impact on the natural environment ■ Dust screen around construction area ■ Excavation, storage and preservation of top soil for later use ■ Protection of on site trees ■ Low flow plumbing fixtures for reduction in water demand by 62 per cent ■ Low grass/lawn area with focus on native trees and vegetation to reduce irrigation demand by 50 per cent ■ Paving of 17 per cent area only - to retain rainwater percolation area ■ Designing a rainwater harvesting system ■ 40 per cent window to wall ratio for optimal natural lighting ■ External shading and glazing to reduce heat ■ Implementing an ECBC compliant artificial lighting system ■ Integration of skylights for day lighting ■ Meeting 30 per cent of annual lighting requirements through solar ■ Meeting 100 per cent hot water demand through solar thermal systems.


Different climate zones of India

Map not to scale

Benefits of green buildings

As compared to conventional buildings a green building:

- consumes 40 to 60 per cent (depending on the range of measures adopted) lesser electricity due to passive architectural interventions in the building design, and high efficiency materials and technologies;
- works for on site energy generation through renewable energy utilisation to cater to its energy needs;
- consumes 40 to 80 per cent lesser water as compared to conventional buildings by utilising ultra low flow fixtures, dual plumbing systems, waste water recycling systems and rain water harvesting;
- generates lesser waste by employing waste management strategies on site;
- generates lesser pollution both during construction as well as while in use, through best practices such as proper storage of construction materials, barricading of the site

> **Building rating systems are a popular tool to bring momentum in achieving energy efficiency and sustainability in buildings.**

> **To promote the green building concept, MNRE in association with TERI has developed Green Rating for Integrated Habitat Assessment (GRIHA).**

to prevent air and noise pollution during construction, proper storage and disposal of waste during construction and operation;

- ensures proper safety, health and sanitation facilities for the labourers (during construction) and the occupants (while in use);
- restricts the use of high ozone depleting potential (ODP) substances in its systems as well as in its finishes; and,
- offers higher image and marketability.

Green building rating systems

Building rating systems are a popular tool to bring momentum in achieving energy efficiency and sustainability in buildings. At present two rating systems - Leadership in Energy and Environment Design (LEED) India and Green Rating for Integrated Habitat Assessment (GRIHA) - are practiced in India.

LEED rating system

LEED was developed and piloted in the USA by the United States Green Building Council (UGBC). The rating system addresses specific environmental building related impacts using a whole building environmental performance approach. The Indian Green Building Council (IGBC), created as a partner organisation to the UGBC in 2001, has adopted the LEED rating system and has launched the LEED India version. The LEED India system gives building ratings of Platinum, Gold, Silver or LEED - certified.

The GRIHA rating system

To promote the green building concept, Ministry of New and Renewable Energy (MNRE) in association with The Energy and Resources Institute (TERI) has developed GRIHA for promotion of energy efficient green buildings in the country. GRIHA is an integrated framework for ensuring design, construction, operation and in turn rating of Energy Conservation Building Code (ECBC) compliant green

The set of GRIHA Manuals: Volume 1-5 is a guide for building professionals - architects, services engineers, landscape designers, project managers and contractors - involved in the design and construction of green buildings. The manuals provide a comprehensive understanding of the GRIHA rating system, including its underlying criteria, rating process, strategies for compliance and documentation and evaluation procedure.

teri
MANUAL VOLUME-5
Technical Manual for Evaluators
A guide for assessing GRIHA documentation
GRIHA
OLUME-4
UME-3
LUME-2
UME-1

GRIHA MANUALS:
Volume 1-5
Paperback (in slip box)
Size: 21.6 cm × 28 cm
Language: English
Year: 2011
ISBN: 9788179934067

Volume 1: Introduction; **Volume 2:** Technical manual for trainers on sustainable site planning, health and well being during construction; **Volume 3:** Technical manual for trainers on building and system design optimisation, renewable energy application; **Volume 4:** Technical manual for trainers on water and waste management, sustainable building materials, health and well being of building occupants, building operation and maintenance; **Volume 5:** Technical manual for evaluators: a guide for assessing GRIHA documentation

▲ **Suzlon - One Earth, Pune, Maharashtra** 5 star rated
Select strategies adopted to reduce building impact on the natural environment ■ Dust screen around construction area ■ Adoption of erosion control systems ■ Utility corridors ■ Low flow plumbing fixtures for reduction in water demand by 65 per cent ■ Recycling and reusing of 55 per cent of water from the complex ■ Low grass/lawn area with focus on native trees and vegetation and installation of sprinklers to reduce irrigation demand by 50 per cent ■ Adequate day lighting and glare control ■ 0.8W/sq ft of lighting load ■ Installation of LED lights on all desks with motion sensors ■ 13.44 kW of solar PV and 18 windmills of 4.75 kW each ■ 250,000 units of electricity generated annually.

buildings. The rating system is suitable to the Indian climate and is in harmony with the National Building Code (NBC) 2005, ECBC 2007 and other Indian Standard (IS) codes. Renewable energy integration is mandated under GRIHA.

GRIHA evaluates the environmental performance of a building holistically, thereby providing a definitive standard for what constitutes a 'green building'. The primary objective of the rating system is to help design green buildings and, in turn, help evaluate the 'greenness' of the buildings. The rating system follows best practices and national/international codes that are applicable to achieving the intent of green design. It has derived useful inputs from the building codes/guidelines being developed by the MNRE, Ministry of Environment and Forests (MoEF), Bureau of Energy Efficiency (BEE) and the Bureau of Indian Standards (BIS).

Objectives of GRIHA

On a macro scale, the rating system seeks to benefit the community at large through,

- reduced energy consumption, resulting in savings on account of reduced energy bills without compromising on human comfort levels;
- integration of solar energy devices, such as, solar water heating systems and roof top photovoltaic (PV) systems to generate on site energy for various requirements;

Fortis Hospital, Shalimar Bagh, New Delhi

- waste recycling and reuse;
- reduced water consumption;
- reduced air and water pollution (with direct health benefits);
- reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc.;
- increased user productivity; and
- enhanced image and marketability

The rating system helps 'design and evaluate' new buildings (the rating process is most useful to projects when implemented at their conceptual stage before designs and specifications are frozen). GRIHA is based on predicted building performance over its entire life cycle - inception through operation. The issues addressed at various stages are:

- Pre-construction stage (intra and inter site issues)
- Building planning and construction stage (issues of resource conservation and reduction in resource demand, resource utilisation efficiency, resource recovery and reuse and provisions for worker and occupant health and well being). The prime resources that are considered in this section are land, water, energy, air and green cover.
- Building operation and maintenance stage - issues of operation and maintenance of building systems and processes, monitoring and recording of consumption, and occupant health and well being and also issues that affect the local and global environment.

GRIHA has 100 points distributed across 34 criteria, some of which are mandatory while the others are optional. Different levels of rating - 1 star to 5 stars - are awarded based on the number of points earned.

GRIHA has 100 points distributed across 34 criteria (Table 1). The framework consists of few core criteria, which are mandatory while the rest are optional. A project has to comply with all the mandatory requirements in order to contend for certification. Further, the project has to score points, which can be earned by complying with the commitment of the criterion against which the point is allocated. Different levels of certification (1 star to 5 stars) are awarded based on the number of points earned. The minimum score required for certification is 50. Buildings scoring 50 to 60 points, 61 to 70 points, 71 to 80 points, and 81 to 90 points will get 1 star, 2 stars, 3 stars and 4 stars, respectively. A building scoring 91 to 100 points will get the maximum rating i.e. 5 stars.

In addition to the 100 points distributed against explicit requirements laid out in the rating system, the project can further claim four bonus points by showcasing achievements in design, construction, operation or maintenance of the building that have significant environmental benefits. As such theoretically, a project can contend for 104 points but shall be judged only over 100 points.

It is also well recognised that some criteria may not apply to a particular project due to technical constraints that are specific to the particular project. In view of the uniqueness of each project and the design and development constraints out of control of the project proponent, it is permitted to claim exemption from being evaluated against a criterion that does not apply to the project. In such cases, a pre-feasibility study shall be carried out by the project team along with the GRIHA Secretariat to demonstrate that the project can be exempt from attempting the specific criteria.

If a project gets exemption from attempting certain criteria, the project shall be rated on a percentage basis on applicable points only. If a project chooses to attempt the bonus points in addition to the applicable ones, the bonus points shall also be counted in arriving at the percentage. The denominator in such

Table 1: Criteria of the GRIHA rating system

Site Selection and Site Planning	**Points**
Criteria 1 Site Selection*	1
Criteria 2 Preserve and protect landscape during construction/compensatory depository forestation.*	5
Criteria 3 Soil conservation (post construction)	2
Criteria 4 Design to include existing site features	4
Criteria 5 Reduce hard paving on site*	2
Criteria 6 Enhance outdoor lighting system efficiency	3
Criteria 7 Plan utilities efficiently and optimise on site circulation efficiency	3
Criteria 8 Provide minimum level of sanitation/safety facilities for construction workers^	2
Criteria 9 Reduce air pollution during construction^	2
Building Planning and Construction	
Criteria 10 Reduce landscape water demand	3
Criteria 11 Reduce building water use	2
Criteria 12 Efficient water use during construction	1
Criteria 13 Optimise building design to reduce conventional energy demand*	8
Criteria 14 Optimise energy performance of building within specified comfort limits*	16
Criteria 15 Optimise building design to reduce conventional energy demand	6
Criteria 16 Reduction in embodied energy of the building	4
Criteria 17 Use low-energy materials in interiors	4
Criteria 18 Renewable energy utilisation*	5
Criteria 19 Renewable energy based hot water system	3
Criteria 20 Waste water treatment	2
Criteria 21 Water recycle and reuse (including rainwater)	5
Criteria 22 Reduction in waste during construction	1
Criteria 23 Efficient waste segregation	1
Criteria 24 Storage and disposal of wastes	1
Criteria 25 Resource recovery from waste	2
Criteria 26 Use of low-VOC paints/adhesives/sealants	3
Criteria 27 Minimise ozone depleting substances^	1
Criteria 28 Ensure water quality^	2
Criteria 29 Acceptable outdoor and indoor noise levels	2
Criteria 30 Tobacco and smoke control	1
Criteria 31 Provide minimum level of accessibility for persons with disabilities	1
Building Operation and Maintenance	
Criteria 32 Energy audit and validation^	0
Criteria 33 Operation and maintenance^	2
Total	100
Innovation	
Criteria 34 Innovation points	4
Total	104
^Mandatory criterion	
*Partly mandatory criterion	

Corporate Office, Unilever, Mumbai, Maharashtra

case would be the sum of the points remaining after excluding the non-applicable ones from the 100 and the number of bonus points opted by the project.

Role of MNRE

The reduction of energy consumption and use of renewable energy in buildings have been a priority for MNRE since long and it has pioneered the modern-day green building concept in the country. The MNRE has come out with many promotional schemes to provide the needed impetus to the green building movement.

Table 2: GRIHA registration-cum-rating fee

Project size (total built up area)	Rating-cum-registration fee
≤ 5000 sq m	Rs 3,14,000 (Rs 2,50,000 fixed cost for registration and secretariat fees + Rs 64,000 for evaluation)
>5000 sq m	Rs 3,14,000 (fixed cost for projects up to 5000 sq m) + Rs 3.75 per sq m over and above 5000 sq m of built area

Green Buildings schemes

The MNRE is at present implementing a scheme on ‘Energy Efficient/Solar Green Buildings’, which promotes green building construction in the country, supports GRIHA ratings and provides incentives for organising workshops, seminars, trainings and creating awareness etc. Under the scheme, owners of the buildings proposed to be rated under GRIHA register with the GRIHA Secretariat and pay the registration-cum-rating fee for the project. 90 per cent of this fee (Table 2) for projects rated 3 star and above, having built area up to 5000 sq m and for projects rated 4 star and above having built area above 5000 sq m is reimbursable by MNRE to the owners through the GRIHA Secretariat after validation of Star Rating (post construction) by the National Advisory Council. Additionally, as an incentive, architects and design consultants are provided up to Rs 5 lakh for each project upon achieving the stipulated targets.

MNRE has modified the provisions of the scheme to exempt the first 100 government/public sector buildings from paying the registration-cum-rating fee to the GRIHA Secretariat in advance at the time of registration. Projects desirous of availing this incentive however have to commit to achieving a high rating. A minimum 3 star rating and above is prescribed for projects smaller than 5000 sq m and a minimum 4 star and above is prescribed for projects larger than 5000 sq m. The prescribed format for 'undertaking' can be obtained from the GRIHA Secretariat. Application for GRIHA rating consisting of registration form, project details, the undertaking given by the competent authority on the official letterhead and the project drawings can be submitted to the GRIHA Secretariat. The GRIHA Secretariat shall conduct a preliminary review of the documents and hold a meeting to confirm compliance with mandatory requirements and evaluate possible level of star rating. Based on the outcome of this meeting, the GRIHA Secretariat shall recommend the sanction of incentives from the Ministry. Projects that are not likely to achieve more than 2 star can still register with the GRIHA Secretariat for rating by paying the registration-cum-rating fees.

The Ministry is also encouraging urban local bodies to formulate green building promotion policies through discounts on premium and property tax by giving them a one time grant of up to Rs 50 lakhs to facilitate the process of policy formulation and awareness building.

The achievements

- The Ministry has created the Association for Development and Research on Sustainable Habitats (ADaRSH) an independent registered society for promotion and implementation of GRIHA rating system in the country.
- The Committee of Secretaries has taken a decision that all new buildings of the Central Government/Public Sector Undertakings (PSUs) would at least meet the requirements of GRIHA 3 stars, though every effort would be made by them to achieve a higher star rating wherever site conditions permit. Ideally, all organisations would aim at reaching GRIHA 4 stars rating.
- So far, 117 projects have already been registered for GRIHA rating certification with 4.98 million sq m built up area. 81 projects out of these are from various government departments, PSUs and educational institutions. A total built up area of 3.38 million sq m has been registered for construction based on green rating norms for acquiring GRIHA ratings.
- Suzlon One Earth, Pune (5 star), Police Training School, Tasgaon (4 star), Fortis Hospital, Shalimar Bagh, New Delhi (3 star) and Hindustan Unilever Limited, Mumbai (2 star) have also been rated under GRIHA, so far.
- The Central Public Works Department (CPWD) has decided to follow GRIHA ratings in all building built by them in the future. CPWD is in the process of amending its work manual commensurate with the GRIHA ratings.
- CPWD Training Institute, Ghaziabad has been recognised as a 'Centre of Excellence for Green Buildings'. The Centre will provide technical and training support to professionals including government officials, engineers and architects, besides consultancy services on green buildings.
- GRIHA Manuals containing a set of 5 volumes prepared under MNRE Project were released by Dr Farooq Abdullah, Hon'ble Minister of New and Renewable Energy in the National Workshop on Green Buildings on 7 January 2011.

Capacity building

A total of 13 'Evaluators and Trainers Workshops' for providing trainings to architects, engineers and officials from Central and State Governments and PSUs including CPWD, National Buildings Construction Corporation (NBCC), National Thermal Power Corporation Ltd. (NTPC) etc., have been organised. Over 600 building professionals have taken part in these programmes and nearly 200 of them have qualified in the examination as trainers or evaluators. These GRIHA certified professionals are further generating awareness about green buildings.

Conclusion

It has become imperative to have all future constructions as green as possible. Although the government has taken a lead in this direction, for substantial results the private sector must come forward. It is the duty of every citizen to protect the environment and use renewable energy as much as possible. Lack of appropriate information and tendencies to follow fashionable trends that are short lived often lead us to provide 'international' comfort conditions in our buildings, at the cost of very high energy consumption. It should be our endeavour to help secure the energy and resource future of our country through green buildings and habitats suitable to our country and people. It is also relevant in the increasing gap between demand and supply of energy in India. Green buildings can play a very vital role in conserving the fossil fuel based energy. When a number of green buildings are located in proximity, they would create a green zone, provide a much healthier environment and minimise the heat island effect. The ultimate aim should then be to create many such areas, which would help the towns and cities and therefore the nation in reducing the total energy requirement and also the overall global carbon footprint. ✪

The author is Director, Ministry of New and Renewable Energy, New Delhi.

For further details on Green Buildings and the GRIHA Rating System please contact CEO, ADaRSH (GRIHA Secretariat) at ceo@grihaindia.org or visit www.grihaindia.org

Development of Solar Cities: Agra

Second stakeholders meeting

Agra's solar city master plan which is ready now was presented at this meeting.

The second stakeholders meeting as part of developing Agra, the City of the Taj, as a solar city was successfully held in the Circuit House, District Magistrate's Office, Agra on 5 March 2011. Agra is a participant in the Ministry of New and Renewable Energy (MNRE), Government of India, programme on 'Development of Solar Cities'. The national programme aims at enabling up to 60 cities to develop master plans or road maps for becoming solar cities through energy reduction targets and action plans. ICLEI – Local Governments for Sustainability, South Asia, a Delhi based NGO was entrusted by the Agra Nagar Nigam (ANN) to prepare Agra's solar city roadmap. The ICLEI Local Governments for Sustainability, prepared the Agra master plan report contains the current energy scenario of the city, the projected business-as-usual demand for the years 2013/18 and also the action plan to reduce the projected demand by 10 per cent.

This master plan of Agra was presented at the meeting to the city's esteemed stakeholders. The meeting was chaired by Shri Deepak Gupta, Secretary, MNRE. Also present were Mr Ajay Chauhan, District Magistrate, Agra; Mr Vinay Shankar Pandey, Nagar Ayukt, Agra Nagar Nigam and Mr Raj Kumar Srivastava, CDO, Agra. The meeting was attended by the presidents of several local industry associations, the architects' association and representatives from Agra's commercial and institutional sectors.

The Secretary, MNRE, answered queries from the stakeholders and also urged the participants to promote the adoption of renewable energy technologies throughout the city.

Several recommendations were made by the stakeholders to ANN and included: inviting public comments for the Solar City master plan, generating awareness about the programme amongst the citizens of Agra, demonstration projects for renewable energy technologies, upgradation of municipal services to increase efficiency, innovative applications of renewable energy such as biogas plants in dairies, holding an exhibition on renewable energy and energy efficiency for citizens and making the plan available online to citizens. Policy level measures, such as amendments to the building bye laws and offering rebates in electricity charges were also suggested. With the master plan for Agra now ready, the city is eager to incorporate the suggestions made during the meeting and move on to the next phase of implementation. ❂

Integrating Green Building Concepts in Public Works

A Seminar On
"Integrating Green Building Concepts in Public Works"
27th - 28th April, 2011
Organised by
CPWD Training Institute, Ghaziabad
CPWD
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Organised by
CPWD Training Institute, Ghaziabad

The Government has mandated a 3 star GRIHA rating for all buildings constructed by the CPWD and this Seminar was organised to drive home the need for Green Buildings across all sections of the Department.

A Seminar on Integrating Green Building Concepts in Public Works was organised by the Central Public Works Department (CPWD) Training Institute at Ghaziabad on 27 and 28 April 2011. Shri Deepak Gupta, Secretary, Ministry of New and Renewable Energy (MNRE), who also declared the CPWD Training Institute as a Centre for Excellence for Green Buildings, inaugurated the programme. He said that with the projected energy demand, thermal energy is not likely to be a solution and renewable sources can meet only part of the requirement, thus Green Construction to reduce the demand has to be taken up aggressively and universally. The Chief Guest, Shri Navin Kumar, Secretary, Ministry of Urban Development (MoUD), emphasised that the CPWD is a prime mover of construction practices particularly in the Government and public sector and it is essential that it takes the initiative to aggressively incorporate green features in the works it takes up. He added that he was confident that the Institute would live up to its responsibilities as a Centre of Excellence in this area.

The speakers at the seminar included officers from MNRE and CPWD, consultants, academicians and representatives from Bureau of Energy Efficiency (BEE) and The Energy Research Institute (TERI). The presentations covered all aspects of Green Buildings including, rating systems, passive architecture, solar appliances, materials, case studies and policy directions.

Shri Sushant Baliga, Additional Director General (Training), CPWD during the opening remarks said that the Seminar had been organised so that the need for Green Buildings is driven home across all the Departmental Officers. Shri C S Prasad, Director General, CPWD stated that the recent policy of the Government of India has ensured Green Rating for Integrated Habitat Assessment (GRIHA) compliance in all future Governments buildings, therefore it is imperative that all personnel in the Government dealing with infrastructure are made aware of Green Buildings and their implications. Shri Vinod Gupta, Architect, Space Design Consultants in the keynote address - 'Building Sustainably' - gave examples of technologies, which had been implemented in a variety of projects.

An Exhibition of Green Building projects - Jawahar Bhawan, for the Ministry of External Affairs and Paryawaran Bhawan, for the Ministry of Environment and Forests both at New Delhi - taken up by CPWD as well as innovative Green Building materials was also arranged at the venue. ✪

Rashtriya Urja Jana-Jagriti Abhiyan

"The IIES 2011 is indeed an important event. The Summit has to discuss how to evolve energy independency policy for the nations. It means nations graduating to renewable energy and the going away of fossil fuels". Dr A P J Abdul Kalam

Rashtriya Urja Jana-Jagriti Abhiyan (RUJJA), in its first phase started as a three tier program of three events - the Urja Yatra from 12-27 January 2011, the 1st India International Energy Summit (IIES) on 28-30 January 2011 at Nagpur and an Energy Expo on 27-30 January 2011 also at Nagpur. It is organised by Vijnana Bharati, New Delhi in collaboration with Ministry of New and Renewable Energy, Government of India with the focal theme of 'Sustainable Energy Development: time for innovation and integrated planning'. RUJJA, an ambitious programme is aimed as a set of inclusive phased activities to appeal to all stake holders - the public, the policy makers, manufacturers and specialists alike. The deliberations, suggestions feedback and the knowledge exchange are expected to accelerate mainstreaming and up scaling of sustainable energy technologies.

The Urja Yatra started from 4 corners of India, crossed through 18 States, covered 8000 kms and culminated at Nagpur, Maharashtra on 27 January 2011. The yatra discovered and highlighted many successful yet unsung experiments in sustainable energy in obscure pockets of India. It served as a conscience nudge to fellow citizens and leaders alike to follow suit to usher in a clean, self reliant, developed India.

IIES was hosted by Visvesvaraya National Institute of Technology (VNIT), Nagpur. It engaged the Government, industry, academia and other activists and was aimed at influencing policy making and program implementation processes in the country. The summit was a meeting of minds to exchange experiences and threw up fresh ideas through a number of papers by successful experimenters as well as researchers. A distinctive feature of this program was the institution of a mechanism to follow up the recommendations with various Government bodies and NGOs and continually assess the impact for ongoing course correction and innovation when required. The event programme included plenary sessions and panel discussions; parallel sessions; local self government's meet; business to business and business to consumers meets; NGOs' meet; students' meet; nationwide renewable energy and energy efficiency competitions; and focused training workshops.

The Energy Expo was a visual treatise of strides the world has made in sustainable energy technologies and achievements that can be emulated and scaled up for benefit of the nation. It showcased the latest trends, technologies, and success stories in the fields of energy efficiency and renewable energy technology applications.

Tripada International School

A geothermal heat pump success story

A step towards renewable energy

Three years back the Tripada International School in Ahmedabad installed a geothermal heat pump to regulate the temperature in its library. The system was installed by Shri Minesh Patel of Geo Clinic. Initially the school hesitated to install the system due to high investment, but now they are quite satisfied with the technology benefits and advantages of the system. The pump has been installed utilising the land of COP/ground area where the loops are buried horizontally. With electricity costs sky rocketing a geothermal/ground source heat pump can be a sustainable alternative. Geothermal heat pumps are a new technology whose benefits include:

- Electricity saving up to 50 per cent
- Negligible maintenance
- Both heating and cooling from one unit
- Equipment life of around 20 years
- Eco friendly system
- Renewable energy
- Invisible technology
- Innovative and aesthetic design
- Lower life cycle cost

Applications: Domestic/residential, hospitals, hotels, clubs, schools, colleges, industries, commercial buildings etc.

Parameters of the system

Heat pump type: water to air
Tonnage: 3 ton
Ground loop: horizontal type
Area of library: 580 sq ft
Loop length: 2160 ft
Loop field area: 60 x 60 ft
Estimated energy saving: 34 per cent. ❂

Green building tech sab apnao
Nature aur money dono bachao.
Pradeep Mehra
Rasiklal Ke Akshay Dohe...

RE TECH

Technology in the area of renewable energy is evolving and expanding its limits at a rapid pace. Here we bring you glimpses of the latest research in and products related to renewable energy.

New gearless wind turbine for low to moderate wind speeds

Siemens Energy has launched a new direct drive gearless wind turbine for low to moderate wind speeds. The core feature of the new SWT-2.3-113 wind turbine is an innovative drive concept with a compact permanent magnet generator. This type of generator is characterised by its simple, robust design, requiring no excitation power, slip rings or excitation control systems. This results in high efficiency even at low loads. With a capacity of 2.3 MW and a rotor diameter of 113 m the new wind turbine is designed to maximise power production at sites with low to moderate wind speeds. The SWT-2.3-113 is fitted with the new Siemens B55 Quantum Blades. This new blade design boosts efficiency and optimises performance. A prototype of the new machine was installed in the Netherlands in March 2011.

www.siemens.com, 14 March 2011

LGate 101 Solar Monitoring System

Locus Energy launched the LGate 101, a power-metre/data-logger that enables solar integrators and developers to collect, monitor and manage performance data from any type of residential photovoltaic (PV) system. Combined with the web-based Locus Platform that provides an overview dashboard as well as patented analytics, the LGate 101 enables solar fleet operators to gather data for troubleshooting, asset optimisation and performance guarantee/billing functions. The LGate 101 has the following features: Embedded ANSI C12.20 class 50 revenue-grade power-metre/data-logger built into a NEMA 3R enclosure; Installation in less than one hour and works with almost any type of inverter; Collection of electricity consumption and revenue-grade PV production data; Inverter-direct communication and fault detection; Communications via Ethernet, powerline or cellular networks; Plug and play connectivity with remote upgrades.

www.locusenergy.com , 29 March 2011

New 20/20 LED lighting system

SOL, Inc. introduced its new 20/20 Solar LED Lighting System, a light-emitting diode (LED) lighting system in the outdoor lighting industry with a distinctive form and engineered optical performance. The 20/20 increases pole spacing and lighting uniformity, simplifying installation with a solar pole. The luminaire, light engine, photovoltaic (PV) assembly and pole of the commercial-grade 20/20 light are designed from the ground up to exceed the demands of modern solar light performance and durability. 20/20's extended battery reserve powers the light through poor weather conditions and SOL's FivePlus System Warranty enables years of lighting. Designed for parking lots, perimeter security, bike paths, walkways, streets and roadways, the 20/20 light can be deployed virtually anywhere to provide light every night. The 20/20 light also offers enhanced autonomy through an intelligent controller that allows dimming or programmed run times.

www.solarlighting.com
22 March 2011

Compact Solar Charger for handhelds

Goal Zero, a creator of portable solar power systems, announced the availability of the Guide 10 Adventure Kit, an efficient compact solar charging system for handheld devices. A lightweight solar charging system created for broad functionality, the Kit functions as a pocket size battery charger for a variety of USB and DC portable devices. Fully charged, the Kit delivers enough portable power to charge a cell phone for 30 hours, a smart phone for 7-10 hours, or an iPod for 40 hours. It consists of a AA/AAA-battery-compatible power pack and a 7 W solar panel system composed of monocrystalline solar cells, providing a high return electricity rate. The durable solar panels attract enough energy to fully charge the AA/AAA batteries in the power pack within 1.5 hours of full sunlight. Users can then charge their handheld devices by connecting them to the compact power pack's USB or 12 V output ports.

www.goalzero.com, 30 March 2011

Inverter for solar plants

AEG Power Solutions has launched a new solar power inverter Protect PV.500. A key feature of the Protect PV product line is its power stack with advanced design measuring and control technology enabling DC input voltages of up to 1000 VDC. Protect PV.500 is directly derived from the technology developed for the highly successful Protect PV.250, whose certified efficiency yields 98.7 per cent according to European standard 50530. With an appropriate transformer, it can also be adapted to the medium voltage grid (e.g. 10, 20, 33 kV). The Protect PV.500 is fully compliant with BDEW guidelines for energy producing installations and thus contributes to overall grid stability. The product has been launched in Europe and Asia, and will soon be available in the US market.

www.aegps.com, 04 April 2011

ROHM Silicon Carbide Schottky Diodes
Push Performance Envelope

ROHM

High Performance SiC Diodes for solar panel inverters

ROHM Semiconductor has released a new series of high performance silicon carbide (SiC) Schottky barrier diode (SBD), featuring industry leading low forward voltage and fast recovery time, resulting in higher power conversion efficiency. The new SCS1xxAGC series are capable of maintaining low forward voltage over a wide operating temperature. The low VF contributes to reduced conduction loss while the ultra short reverse recovery time enables high speed switching, while minimises switching loss.

http://japantechniche.com, 05 April 2011

Advertise in

Akshay Urja

is widely circulated to all stakeholders of renewable energy. Akshay Urja invites advertisement (in colour) from interested organisations, manufacturers, institutions, etc. The advertisement tariffs are as follows:

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Avail a discount of 20 per cent on 3 consecutive and 25 per cent on 6 consecutive advertisements.

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New Delhi-110003
Tel: +91 11 2436 3035, 23360707
Fax: +91 11 7413, 2436 1298

and labelling programme.

Environmental Impact Assessment

The MoEF's EIA is an important measure for ensuring optimal use of natural resources for sustainable development. EIA was made mandatory in India under the Environmental Protection Act (1986) for 29 categories of large scale developmental activities. The requirement for building energy performance in the EIA is a combination of related terms in NBC and ECBC. The EIA requirements are extremely pertinent and relevant, and if properly implemented, will result in a significant reduction in the environmental impact of buildings. In fact, buildings complying with the requirements of the MoEF's EIA will fulfil most of the requirements of popular green building rating systems.

Green building rating systems

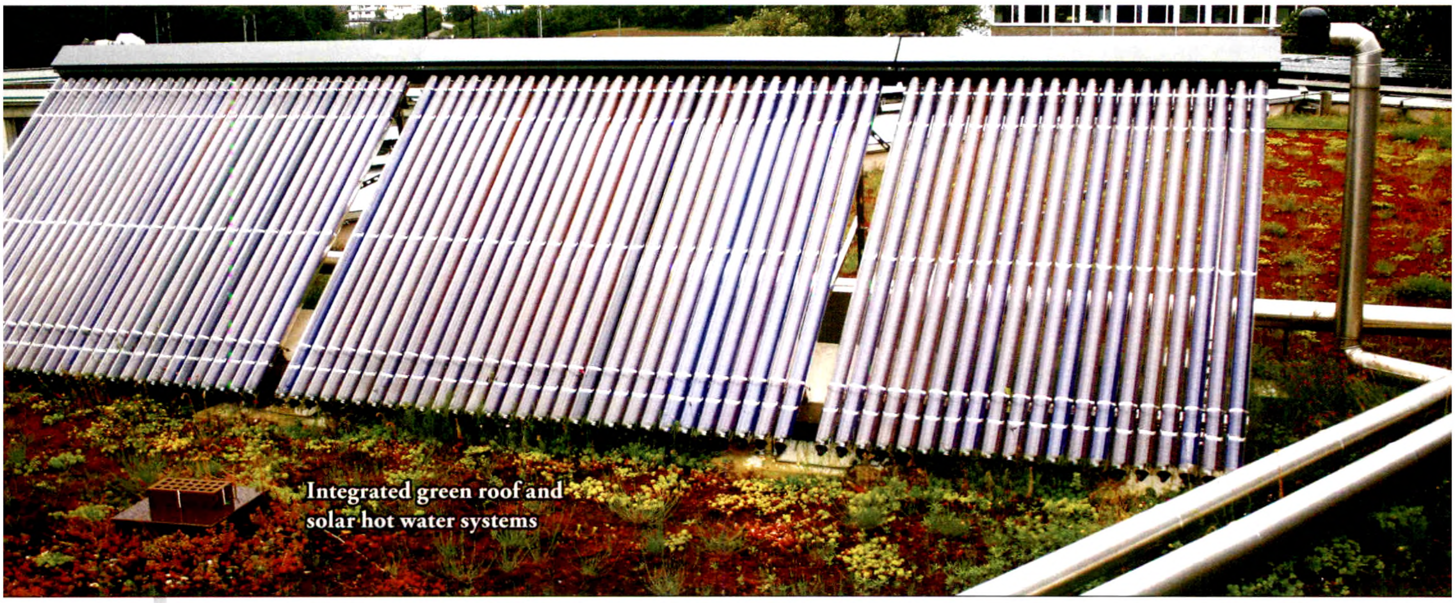
There are two major green building rating systems currently operating in India: LEED India and GRIHA. Industry associations and the private industry have played an important role in promoting the green building movement in India. The Indian Green Building Council (IGBC) is facilitating the Leadership in Energy and Environmental Design (LEED) rating of the United States Green Building Council (USGBC) in India. It has developed several India specific ratings, namely LEED-India, Green-Homes and Green-Factories. The IGBC also offers training, technical assistance, and other capacity building programmes to industry associations and industries.

The Energy and Resources Institute (TERI) jointly with the Ministry of New and Renewable Energy (MNRE) has developed the Green Rating for Integrated Habitat Assessment (GRIHA) for the emerging energy consuming segment - the commercial, institutional and residential buildings. GRIHA has now been adopted as the national green building rating system and MNRE has developed incentives to promote it among architects and building owners. Additionally, MNRE has initiated several programmes for the integration of renewable energy in buildings.

Key barriers to building green in India

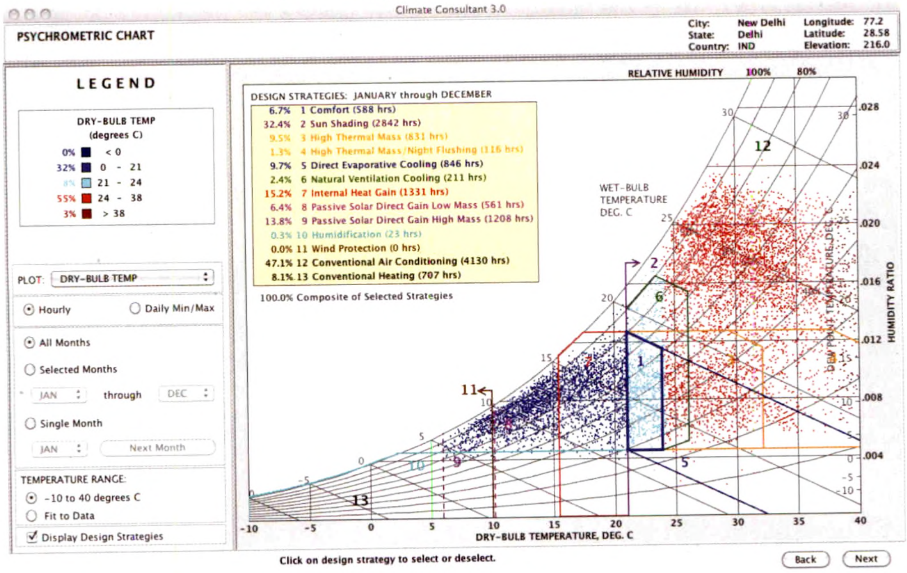
Sustainable building design and construction practices face a number of complex and interrelated barriers which can operate at various levels starting from government policy to the technical expertise and knowledge of a construction site worker. One key barrier to green buildings in India is the adoption of inappropriate western design and comfort ideals. Even though the climatic conditions and lifestyle in the west and consequently the building designs are drastically different, there is a tendency among the Indian design industry and building owners/developers to ape them. This is a critical barrier to effective energy efficient design in the country. Although there are several excellent examples of traditional buildings that maximise thermal and visual comfort in buildings, these traditions need to be transformed and adapted for modern design of commercial buildings.

At the policy level, tough mandatory standards are seen more as an impediment to growth and industry and most programmes prefer to opt for voluntary compliance and less stringent standards. This attitude is shifting slowly after the success of some of the industry and appliance standards programmes. International examples have proven that mandatory and uniformly implemented codes and standards are the only way to achieve substantial impact of any energy efficiency measure.



Integrated green roof and solar hot water systems

Integrated design strategies based on climate



Climate Consultant 3.0

PSYCHROMETRIC CHART

City: New Delhi
State: Delhi
Country: IND
Longitude: 77.2
Latitude: 28.58
Elevation: 216.0

LEGEND

DRY-BULB TEMP (degrees C)

0%	■	< 0
32%	■	0 - 21
8%	■	21 - 24
55%	■	24 - 38
3%	■	> 38

PLOT: DRY-BULB TEMP

● Hourly ○ Daily Min/Max

● All Months
○ Selected Months
JAN through DEC
○ Single Month
JAN Next Month

TEMPERATURE RANGE:
● -10 to 40 degrees C
○ Fit to Data

☑ Display Design Strategies

DESIGN STRATEGIES: JANUARY through DECEMBER

6.7%	1 Comfort (588 hrs)
32.4%	2 Sun Shading (2842 hrs)
9.5%	3 High Thermal Mass (831 hrs)
1.3%	4 High Thermal Mass/Night Flushing (116 hrs)
9.7%	5 Direct Evaporative Cooling (846 hrs)
2.4%	6 Natural Ventilation Cooling (211 hrs)
15.2%	7 Internal Heat Gain (1331 hrs)
6.4%	8 Passive Solar Direct Gain Low Mass (561 hrs)
13.8%	9 Passive Solar Direct Gain High Mass (1208 hrs)
0.3%	10 Humidification (23 hrs)
0.0%	11 Wind Protection (0 hrs)
47.1%	12 Conventional Air Conditioning (4130 hrs)
8.1%	13 Conventional Heating (707 hrs)

100.0% Composite of Selected Strategies

Click on design strategy to select or deselect.

In the absence of mandatory standards for green and energy efficient buildings in India, most municipalities do not have a uniform and practicable energy code especially for passive and solar designs. There are no clear implementation guidelines in place for state and municipal bodies to develop and implement building energy efficiency programmes and policies. There is also no effective local implementation infrastructure for code administration and enforcement including code checking and inspections.

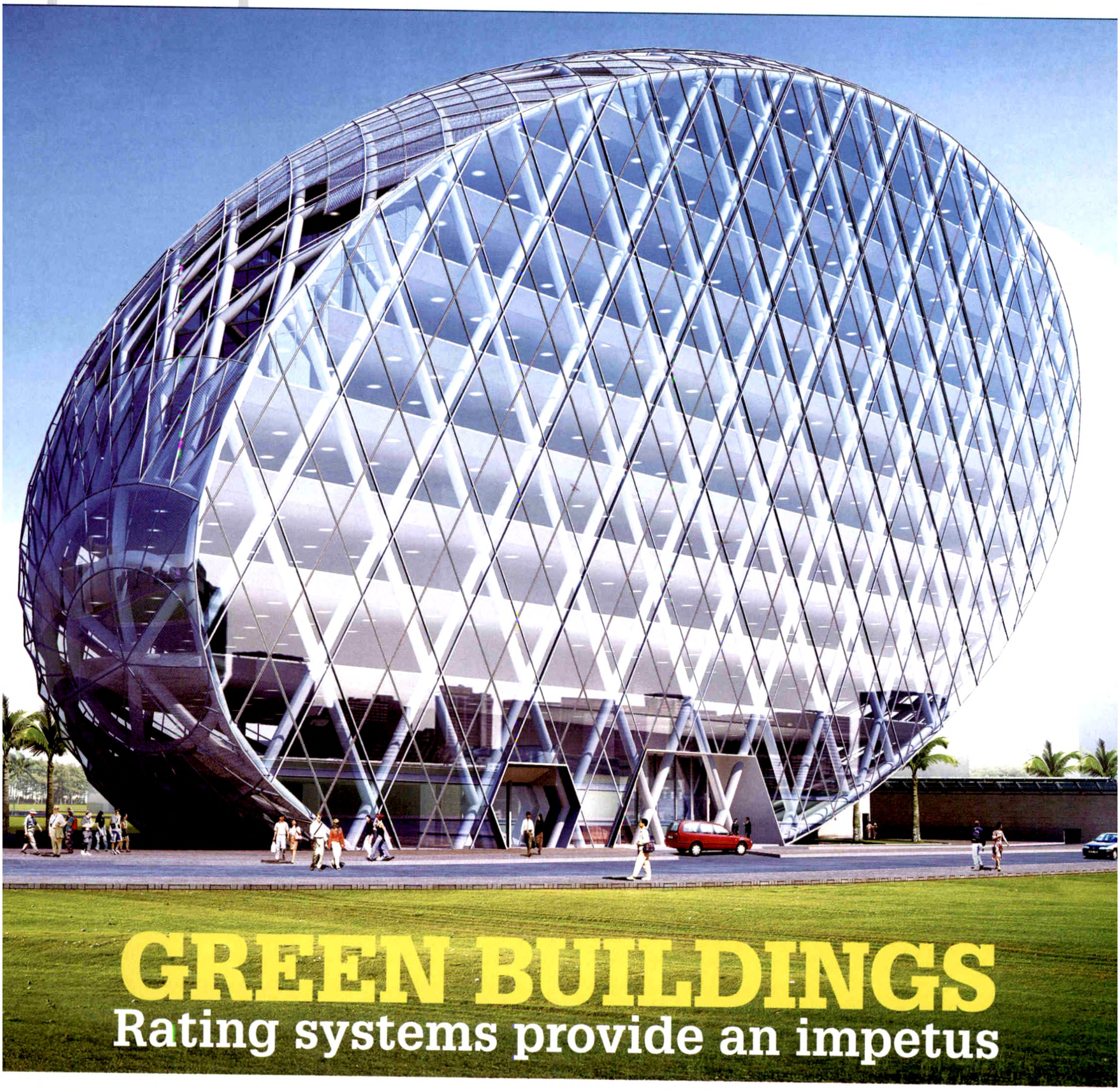
Building owners tend to under invest in green technologies and energy efficiency during building design and construction because of the split incentives. The developers do not gain from the initial investments in building energy efficiency and thus pass on the cost of inefficiency to the tenants and the environment. The current high cost of borrowing can be a strong impediment to incremental funding in efficiency that would be offset by future savings of energy costs.

> **At the policy level, tough mandatory standards are seen more as an impediment to growth and industry and most programmes prefer to opt for voluntary compliance and less stringent standards.**

Overcoming the barriers: implementation approach

The approach to transforming the current construction paradigm towards a more sustainable approach can only be achieved through collective effort, involving all the major stakeholders in the construction industry, the policy makers, the financial institutions, end users, and the developer community. A detailed action plan with time and result bound targets needs to be developed in close consultation with these stakeholders. At the policy level, there is still not enough significance given to the building sector. Although the process of implementing the current ECBC, with its moderate stringency levels, is in progress; a more dynamic and long term future orientation of building energy policy is needed. The future with a zero net energy building target, therefore, is the next major leap forward in the policy approach. A transparent, flexible, and effective implementation mechanism needs to be developed in order to overcome the traditional code compliance related concerns. The implementing agencies need to be strengthened and supported with technical details and best practices. They also need to be monitored to ensure transparent enforcement. Although India has one of the highest electricity tariffs for commercial buildings and the costs of renewable energy systems are coming down, a major barrier to the widespread adoption of renewable energy and energy efficiency technologies is the initial cost of investment. A larger market for such products and technologies; a policy environment providing substantive incentives for development and implementation; and import of energy efficient products/ technologies are necessary for high performance buildings to be mainstreamed.

The author is Director, Environmental Design Solutions (EDS), New Delhi.



GREEN BUILDINGS

Rating systems provide an impetus

Today almost every major country has its own green building rating standard.

Hendrik Rosenthal

The recent focus on green buildings in Asia is an encouraging trend for an industry that is both resource intensive and energy hungry.

However, much remains to be done if we are to capture the hidden value of carbon that the industry has to offer.

Green building rating systems provide a good start. Major jurisdictions around the world developed their own green building rating systems some time ago, notably the Leadership in Energy and Environmental Design (LEED)

Improvements in energy efficiency are the key to unlocking massive carbon reduction potential. The industry still has some way to go before it can understand and account for its wider impact on society and the planet.

in the United States and the BRE Environmental Assessment Method (BREEAM) in the United Kingdom. In the Asian region, though new systems started sprouting up only in the last several years; today almost every major country has its own green building standard. And one of the latest additions is the Indonesian Greenship Rating Tool for New Buildings.

That's all fine and well but voluntary standards alone do not make a building, let alone a whole sector of the economy, green or sustainable. From a regional context, a really promising part of green building standards is the fact that Singapore has moved to level the playing field by requiring all new built structures to achieve a minimum level of efficiency and 'green' based on the local Building and Construction Authority (BCA) Green Mark scheme. India is experiencing a boom of green buildings – 96 projects in Mumbai alone have been registered with the Indian Green Building Council (IGBC). But building regulations that mandate certain green features like solar panels or efficiency measures like double glazed windows are still far away.

Buildings consume a tremendous amount of resources for construction, ranging from basic mining and resource extraction (primarily for steel, concrete and timber), to building material processing (primarily from steel, concrete and timber), to construction techniques (primarily using steel, concrete and timber). On the surface an efficient construction material supply chain has evolved in the region, especially if one considers economies of scale and abilities to make profits. However if one looks at this supply chain more deeply to identify the source of materials, difficulties from a sustainability perspective become apparent. Questions about carbon intensity of construction materials, or queries about social and environmental impacts of manufacturing processes, are often met with resistance and at times plain ignorance on part of both the supplier/manufacturer as well as the construction contractor. Many companies operating in the industry simply to do not know their environmental and social impacts, and are even less able to quantify their impact on climate change via carbon foot printing. The industry still has some way to go before it can understand and account for its wider impact on society and the planet.

Energy intensity of building operations is the other important component of a building, representing over 70 per cent of a building's lifetime carbon footprint. Efficient operations of lighting, appliances, heating and cooling equipment, as well as building management systems are not only dependent on the purchase of the most up to date technologies but are heavily influenced by building design. Thermal heat transfer is arguably the most significant component of heat and cooling loss – primarily influenced by external walls, selection of window types and site location. The building envelope as an energy saving feature has been ignored in most tropical countries with the onslaught of air conditioning systems, based on the argument that insulation to protect from sub zero temperatures is never required anyway. Fortunately, changes in building design have been forthcoming and have adapted to the climatic conditions relevant for South and South East Asia. Green building standards have helped in this regard.

An excellent example of an ongoing project is the Cybertecture Egg currently in the conceptual design stage for a site at the Bandra Kurla Complex in Mumbai. Developed by lead architect James Law from Cybertecture, it won the CNBC Asia Pacific Commercial Property Awards 2009 – The Architecture Award India. The project pushes building design traditionally based on concrete and steel to a whole new level, one that allows for maximum gains in space and performance while utilising construction materials with outmost efficiency and care.

As such, green building rating systems are only one part of the puzzle and by themselves do not solve the myriad issues the industry is facing today. But it is encouraging that countries around the Asian region have developed their own standards, clearly showing that sufficient knowledge and commitment exists. There is purpose also in this development, whereby standards are being made relevant to local regulations and climatic conditions. However, there is the danger that this multitude of standards may dilute the overall sustainability objectives by watering down minimum levels of efficiency in particular and material selection more broadly. ✪

The author is Project Director, Association for Sustainable and Responsible Investment in Asia (ASrIA), Hong Kong.

The last couple of decades have seen a significant increase in the share of the service sector in the Indian economy leading to an ever increasing demand for office space. A demand which started in metro cities, that too only in central business districts (CBDs), has now expanded to the suburbs of the metros as well as to tier II and tier III cities in the country. Modern office buildings cater to higher quality working standards, essential for sectors like information technology, financial services etc., for attracting customers as well as employees. However, the energy performance index (EPI) of such spaces in India ranges from 200 to 400 kWh/sq m/year whereas similar buildings in developed nations have an EPI of less than 150 kWh/sq m/year.

The importance and need for energy efficiency has been growing among the government, corporate and individual consumers in India. Apart from an urge to develop a sustainable environment, the need to reduce the cost of energy has also been a motivator for the various stakeholders. It has been estimated that globally building activities contribute about 50 per cent of air pollution, 42 per cent of greenhouse gases, 50 per cent of all water pollution, 48 per cent of all solid wastes and 50 per cent of all chlorofluorocarbons (CFCs) to the environment, thus vindicating the concern.

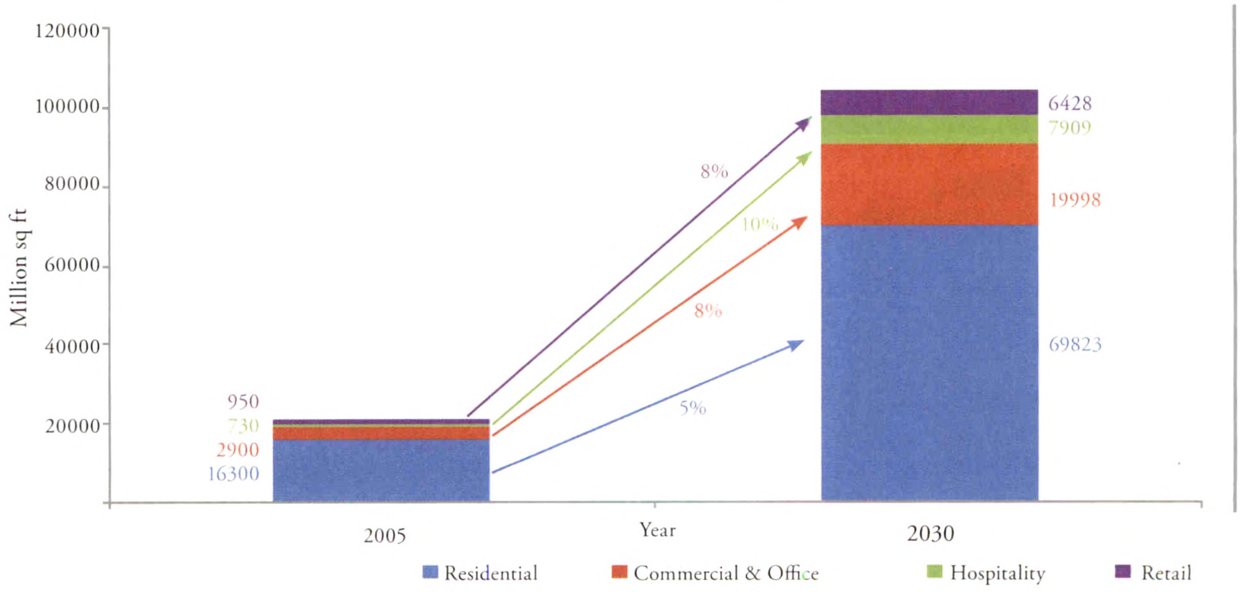
The increasing energy needs

Buildings account for approximately 30 per cent of the overall electricity consumption in the country, it is critical that policy interventions are made to improve energy efficiency in both new construction as well as existing buildings. Commercial buildings or establishments have been included in the list of industries and other establishments under the Energy Conservation Act (2001), but so far they have not been notified as a Designated Consumer. The rapid increase in the energy intensity of commercial buildings has been under the government scanner for a while now. Though the overall share of the commercial sector in electricity consumption is only about 6.6 per cent, it has been growing at a rate of 11-12 per cent over the last few years. This rate of increase in energy consumption is much more rapid than the rate of increase in the floor area of commercial buildings, which is about 9 per cent per year.

Towards achieving energy efficiency

There are a number of measures such as building codes, policy interventions, labelling/rating systems, appliance standards, etc. to streamline efforts to promote energy efficiency in the buildings sector. Building rating systems are a popular tool to add momentum in achieving energy efficiency. These help in assessing the level of performance of the building and provide opportunities in reducing the operation and maintenance (O&M) costs of the building besides creating a market pull towards environmentally sustainable buildings. However, most green rating programmes are based on design intent and do not rate energy performance of existing buildings through a systematic evaluation process.

Future trend of building sector in India



Source: Growth of Indian Building Sector (CWF, 2010)

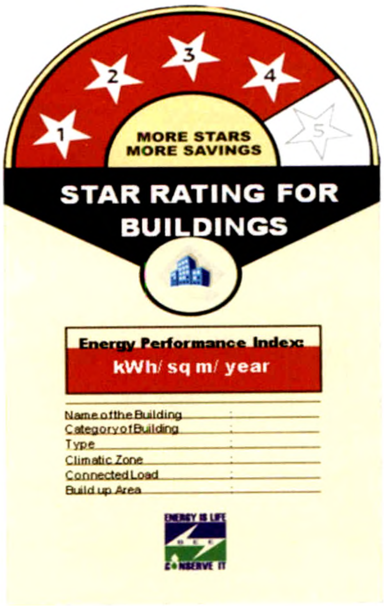
In order to enable rapid transformation towards energy efficiency in buildings, policies and measures that create a 'supply push', such as codes and standards need to be supplemented by policies and measures that simultaneously create a 'demand pull' as well. This 'demand pull' attracts building users towards energy efficient buildings, and thus creates a preferential market demand. On the 'supply push' side, BEE has developed the Energy Conservation Building Code (ECBC) which provides minimum energy performance standards for energy efficient commercial buildings with a connected load of 100 kW and above. The ECBC is currently a voluntary programme, with a number of states adopting it as a mandatory requirement. Further both Leadership in Energy and Environmental Design (LEED) and Green Rating for Integrated Habitat Assessment (GRIHA) rating systems have adopted ECBC as a minimum compliance requirement.

BEE has developed a Star Rating programme for buildings which is based on the actual performance of a building in terms of its specific energy usage in kwh/sq m/year. This programme rates office buildings on a 1-5 Star scale, with 5 Star labelled buildings being the most efficient. The scheme is propagated on a voluntary basis and the label provided under it is applicable for a period of 5 years from the date of issue. The Star Rating programme provides public recognition to energy efficient buildings, and creates a 'demand side' pull for such buildings. Various categories of buildings such as office buildings (day use and business process outsourcing (BPOs)), shopping malls, hotels, hospitals and IT parks in the five climatic zones of the country have been identified under the scheme.

The rating normalises for operational characteristics that define the building use, hours of operation, climatic zone and conditioned space. Further to provide a useful benchmark the rating also provides a meaningful comparison to the building's peer group representing those buildings that have the same primary business function, and operating characteristics. It is important that the rating be based on an analysis of national data that accurately reflects the distribution of energy use for each building type.

The national energy performance rating is a type of external benchmark that helps energy managers to assess how efficiently their buildings use energy, relative to similar buildings nationwide. Additionally, building owners and managers can use the performance ratings to help identify buildings that offer the best opportunity for improvement and recognition.

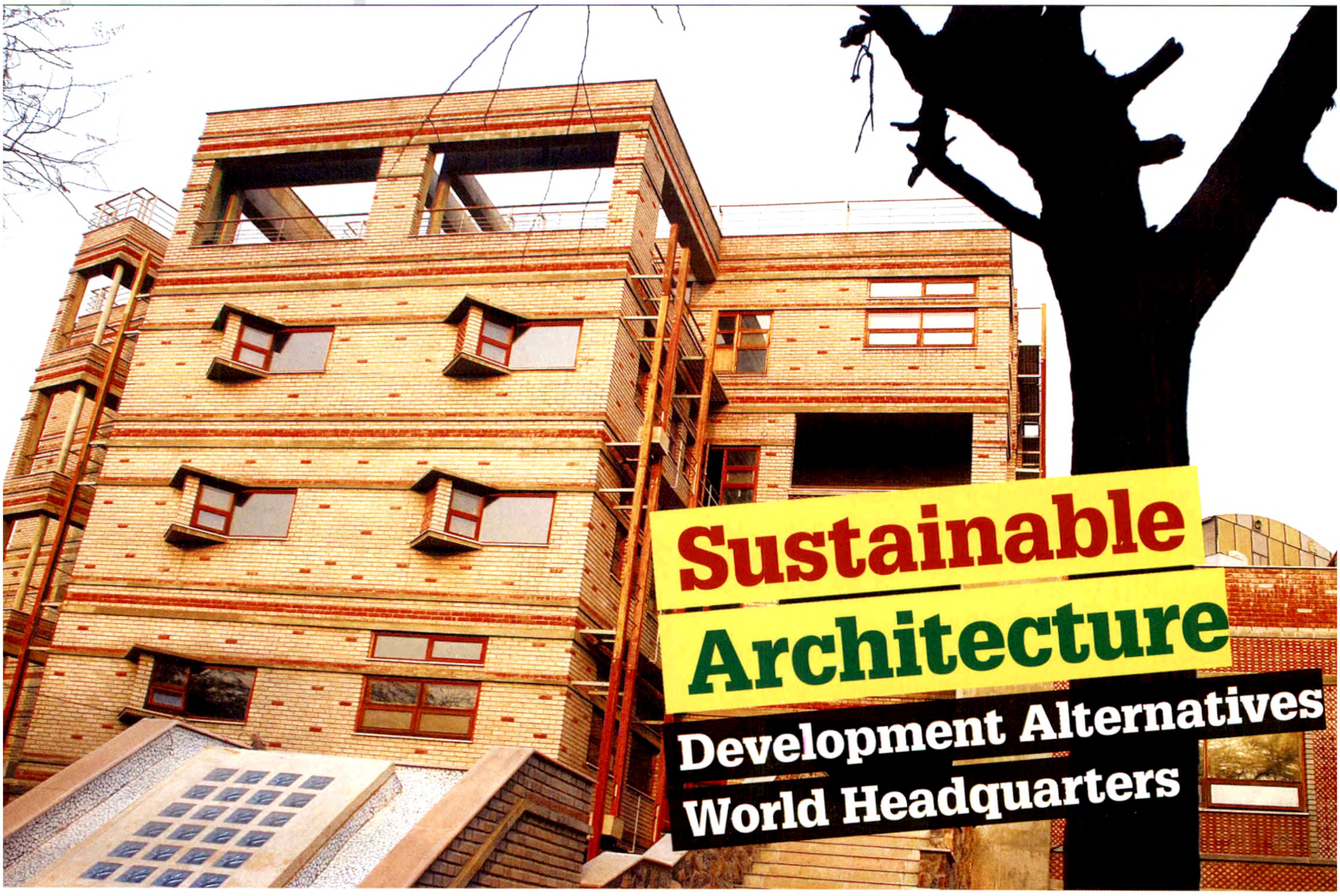
BEE continuously reviews its technical approach to the development of the rating system to ensure an accurate, equitable, and statistically robust rating, because each building type has unique features that impact energy efficiency. BEE has also taken up the exercise of standardisation of energy data collection which assists in comparative assessment and target setting in existing buildings. In case of new constructions, benchmarked energy consumption data helps in more effective implementation of ECBC.



> **In a developing economy like India improved energy efficiency is a primary goal which could be achieved through promotion of higher performance standards in buildings.**

As the benchmark energy performance of commercial buildings also requires energy performance of various elements of building, BEE has initiated an energy rating programme for window facades, insulation, etc. thus equipping the end consumer with a more informed choice. In a developing economy like India improved energy efficiency is a primary goal which could be achieved through promotion of higher performance standards in buildings. Building rating and verification systems are an effective measure to encourage building owners to go beyond the minimum. Creating an awareness of these systems would add substantial momentum to promote energy efficiency in buildings. ✪

The author is Energy Economist in charge of Building Programme, Bureau of Energy Efficiency, Government of India, Ministry of Power.



Sustainable Architecture

Development Alternatives World Headquarters

The design, materials, and techniques used to make the Headquarters demonstrate a fundamental alternative for the construction of comfortable, green, and affordable buildings of many types. **Zeenat Niazi**

The Development Alternatives (DA) World Headquarters building in New Delhi exemplifies environmentally sustainable architecture and can be described as a living ecosystem. The building is a fine balance of natural and man made processes employing environment friendly energy, material and water management methods. The DA World Headquarters includes spaces for offices, training facilities, conferences and technical research.

Quantum change and transferability

The design, materials, and techniques of the DA World Headquarters demonstrate a fundamental alternative for the construction of comfortable, green, and affordable buildings of many types. The project tests innovative, specially designed elements and components such as a hybrid air handling unit that incorporates available components in a new way to achieve great energy savings. Nearly all interior and exterior walls are built of cement stabilised, compressed earth block and cement stabilised fly ash, lime gypsum block, the manufacture of which recycles plentiful local materials in processes that use local labour and low energy. The project points toward the potential of efficient industrialised production of simple, reliable, low energy building materials that, when broadly adopted, will help curtail the massive energy consumption and carbon dioxide emissions. By offering its research and development as the first step of commercialisation, the project is a catalyst for the mass production of green building components.

Ecological quality and energy conservation

Efficiently built in reinforced concrete and masonry, the building uses less than half the reinforcing steel used in comparable structures of conventional design. The approach holds significant potential for reducing resource consumption and greenhouse gas emissions. The World Headquarters uses predominantly natural, recycled, renewable, and reusable materials embodying low process energy. Highly energy intensive materials like aluminium are shunned; others, such as glass and steel, are used frugally. 80 per cent (by volume) of the building materials were sourced within 500 km of the site, thus holding down carbon dioxide emissions of transport. All rainwater that falls on the site is used to recharge the groundwater. All wastewater is recycled, treated on site and used for irrigation and flushing toilets. Hybrid air handling units integrate evaporative cooling and refrigerant based cooling to reduce energy consumption for air conditioning by thirty per cent, and to reduce water consumption.

Ethical standards and social equity

The ground floor and the outdoor areas of the DA World Headquarters are open to the public, inviting public participation in the programmes and activities of the organisation. The entire building is barrier free. The project was conducted in a structured way in consultation with the client and users. Consensus was established at each stage of design development, capped by a peer review by architects and environmentalists. All workspaces enjoy an equal level of comfort and view. Each working group is given its own sense of identity and a feeling of belonging to and interacting with a larger community. The project used simple local materials and local labour to direct money into the pockets of local workers and local construction trade. Traditional construction skills and fine craftsmanship were integral to the design. During construction, adequate accommodation was provided for the migrant workers who lived on the site, including day care for their children.

Economic performance and compatibility

The environmentally friendly construction techniques and mechanical systems used in the building cost no more than their conventional energy intensive counterparts. Economical local materials, simple technology, and local labour were employed to keep construction costs low. Maintenance costs are minimised by using unfinished, durable, natural materials selected to age with grace. Operating cost is kept low by natural lighting of all workspaces and a flexible and efficient hybrid cooling system. The project illustrates traditional, environmentally efficient construction materials and systems that can be economically developed for low energy mass production and adopted by the mainstream building industry, especially in developing countries.

> **The environmentally friendly construction techniques and mechanical systems used in the building cost no more than their conventional energy intensive counterparts.**

Contextual and aesthetic impact

Responding to its physical setting, the DA World Headquarters forms a visual anchor at the end of the city street on one side and shows reverence to the calm forest on the other. The significance of the historic city forest as an ecological asset is heightened by how the building embraces the forest. The work of architecture is a symphony in masonry, with nearly a dozen types of brick, block, and stone used in a variety of patterns to create walls, columns, arches, domes, floors, and stairs - orchestrated to create a harmonious whole that delights the senses. The building combines modern technology with forms, materials, and elements of traditional Indian architecture to exemplify how regional design and simple means can adequately and durably meet the needs of most buildings in contemporary cities. The building design expresses Development Alternatives' concern for people and the environment through the use of natural materials, and by cultivating a stimulating and lively workplace. ✪

The author is Programme Director for Habitat, Development Alternatives, New Delhi.

Green Building Initiatives in India

The journey since 2001

An initiative of the Confederation of Indian Industry-Sohrabji Godrej Green Business Centre (CII-Godrej GBC), the IGBC has a vision to facilitate the country to emerge as one of the global players in green buildings by 2015.

By **Srinivas S**

CII-Sohrabji Godrej Green Business Centre, Hyderabad (Platinum rated)

In the recent past India has experienced a significant growth in the building sector and construction is one of the largest economic activities in the country today. As the sector grows, preserving the environment poses a plethora of challenges, while at the same time it presents an opportunity for various stakeholders. The resource demand in buildings has also been growing over the years and there is an urgent need to minimise the use of resources without sacrificing the overall growth and development of the sector. Green buildings can have tremendous benefits - both tangible and intangible. Tangible benefits include reduction in water and energy consumption from day one of occupancy. The energy savings could range from 20 to 30 per cent and water savings around 30 to 50 per cent. The construction sector therefore needs to play a responsible role towards preservation of the environment.

Green building movement in India

Against this background, in 2001 the Indian Green Building Council (IGBC) embarked on the path to usher in a green building movement in the India. IGBC is an initiative of the Confederation of Indian Industry-Sohrabji Godrej Green Business Centre (CII-Godrej GBC) and the vision of the council is to facilitate the country to emerge as one of the global players in green buildings by 2015. IGBC has the unique distinction of pioneering and spearheading the green building movement in India. The concerted efforts of all the stakeholders which began ten years ago are bearing fruit and India is now placed on the international map of green buildings. Today, India has 1002 registered green building projects with a footprint of over 627 million sq ft. These buildings are spread across the five climatic zones of the country.

Launch of LEED 2011 for India

A major milestone for the Indian green building movement was the launch of the Leadership in Energy and Environmental Design (LEED) 2011 for India by IGBC on 24 February 2011 in New Delhi the ACREX exhibition, organised by the Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE). Mr Mark McCracken Chairman, U.S. Green Building Council (USGBC) launched the LEED 2011 for India reference guide in the presence of Dr Prem C Jain, Chairman, IGBC and Ms Lynn G Bellenger, President the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

Based on the international LEED platform, this new version of the rating has been indigenised and christened 'LEED 2011 for India'. It has been developed with extensive participation of the various stakeholders in the Indian building sector. The new rating system has come into effect from April 2011. IGBC also gives an option to ongoing projects registered under LEED India new construction (NC) 2007 to transit to LEED 2011 for India, if they so desire.

> **Based on the international LEED platform, the new version of the rating has been indigenised and christened 'LEED 2011 for India'. It has come into effect from April 2011.**

Major changes in LEED 2011 for India

The LEED 2011 for India version has been upgraded based on the cumulative experience from the implementation of green building projects in India. The major improvements are:

- Extensively promoting local regulations in areas where the referenced codes are not widely available to Indian building industry.
- Adopting the latest versions of standards and codes to benchmark Indian buildings with the most evolved international green practices.
- Indigenising sustainable transport requirements under site sustainability, by accommodating many types of eco friendly local conveyances.
- Enhancing energy and water efficiency baselines at par with the best international standards and practices. Also addressing the interlinked balance between water and energy by encouraging use of innovative wastewater treatment to meet air conditioning makeup.
- Encouraging passive cooled buildings by adopting comfort temperature range for Indian conditions.
- Reducing the radius of 'regional' materials to those sourced within a distance of 400 km, proportionate to the geographical size of India.
- Promoting naturally ventilated buildings through prescriptive measures for ventilation and indoor environmental quality (IEQ) standards to benchmark naturally ventilated buildings.
- Extending the low volatile organic compounds (VOC) requirement to cover a wider variety of flooring systems,

Tangible benefits - energy savings achieved in green buildings

Building	Area (sq ft)	Normal building (kWh)	Actual building (kWh)	Reduction percentage	Annual energy savings (Lakh Rs)
Wipro, Gurgaon	1,75,000	48,00,000	31,00,000	40 per cent	102
ITC, Gurgaon	1,70,000	35,00,000	20,00,000	45 per cent	90
CII-Godrej GBC	20,000	3,50,000	1,30,000	63 per cent	9

> **The next edition of IGBC's flagship event - the Green Building Congress 2011 is slated from 19-23 October 2011 at New Delhi.**

IGP Office, Gulbarga (Gold rated)

adhesives and sealants etc., for better indoor air quality (IAQ) standards.

IGBC Green Townships (Pilot) Rating System launched

On 27 January 2011, Dr B S Yediyurappa, Hon'ble Chief Minister of Karnataka released the CII-IGBC Green Townships (Pilot) Rating System at 'Municipalika 2011' organised at Bengaluru. The IGBC Green Townships Rating System is designed to address the issues of urban sprawl, automobile dependency, and social and environmental disconnect. This gives a unique opportunity to design townships and large developments in facilitating a low carbon growth path for India.

Benefits of green townships

By incorporating the green features, townships will have the following benefits:

- Efficient transit network to minimise vehicular pollution
- Enhanced quality of life
- Pedestrian and bicycle networks in satellite cities
- Local employment opportunities
- Efficient use of resources (energy and water efficiency of 30 to 50 per cent)
- Local food production
- Effective solid waste management

IGBC - AP exam

In order to meet the increasing demand for green building professionals required to facilitate green construction in India, IGBC has launched the Accredited Professionals (IGBC-AP) exam. This is a credential to professionals to facilitate construction of green buildings in India. As on March 2011, India has over 415 qualified professionals.

Green Building Congress

To reach out to a wider cross section of the community, IGBC conducts various outreach programmes which includes IGBC's flagship event on green buildings - the Green Building Congress. It is held in a different city every year with an aim to educate, inform and network the latest updates, technological innovations, emerging concepts and technologies, etc., with all the stakeholders to enable the spread of the green building movement in India. The next edition of the congress - Green Building Congress 2011 is slated from 19-23 October 2011 at New Delhi.

Green Building material

IGBC plays a catalytic role in demonstrating that 'green' makes business sense. A whole range of green products have been introduced by the green movement. A tremendous potential exists for materials and equipment like building integrated photo voltaic (BIPV), heat resistive paints, fly ash blocks, insulation materials, high efficiency chillers, variable frequency drive's (VFDs), high efficiency cooling towers, building management systems (BMS), lighting controls, etc. Eco friendly technologies like solar air conditioning, wind towers, geothermal system, earth tunnel cooling, etc., integrated with developing townships can cut down energy requirements sizeably. The market potential for green building products and technologies is estimated to grow to USD 100 billion by 2015.

Green buildings will redefine the way buildings are constructed across the globe. Increased awareness and focus on sustainability has brought into focus the need to foster and promote such buildings. In the days to come neighbourhoods, townships, schools, hospitals, etc., - all will go the 'green' way.

Conclusion

The green building experiences in India have been exciting and challenging so far. Since its introduction in 2001, the green building concept has emerged as a useful tool in designing sustainable buildings. The steady increase in green building projects is a clear signal that they are here to stay and are all set to redefine the way buildings are constructed in the nation. The early foray in green buildings has placed India in a leading position and the movement is well poised to reach greater heights in the nation. ❂

The author is Principal Counsellor, Confederation of Indian Industry, CII-Godrej GBC, Hyderabad.

Green IRRAD building

at Gurgaon, Haryana

Leading by example

A frugal and environmentally sensitive structure, the building presents a strong case for cost effective, creative, simple and sustainable architecture.

By **Ashok B Lall**

The Institute of Rural Research and Development (IRRAD) building in Gurgaon is a frugal, environmentally sensitive structure that symbolises the SM Sehgal Foundation's dedication to rural development. Concerned about increasing energy consumption, the Foundation was particular about the workspace architecture being sustainable and entrusted us with the task. The brief was clear - use as many natural materials as possible and try to reduce dependence on energy.

Thus to maximise the use of daylight and minimise the need for air conditioning our architectural team turned the conventional practices of interior design upside down. If one looks at the building in totality it becomes clear that there is a strong relationship between the indoors and the courtyard. There is continuity in the building - offices, classrooms, boardrooms and exhibition areas are all related to the outdoor space.

Basics of light and air

Natural light plays a very important role in all the functional spaces of the IRRAD building, which require artificial light only on overcast days. The quantity of light has been modulated based on the positioning of the building and by using fixed blinds. Only classrooms have movable blinds to shut out light during film projections. The auditorium has

the option of using both natural as well as artificial light, with the help of a simple pulley. To maintain the relation between light and energy, shading systems have been designed in such a way that practically no sun hits glass.

Timber has been used instead of aluminium for air conditioner grills, since it is renewable and helps reduce energy consumption. It was ensured that most of the timber was sourced from managed forest resources. Since the building optimises on natural ventilation the need for air conditioning was considerably reduced and the building requires air conditioning only for about 60-70 days in a year. Air conditioning ducts therefore run through a very limited area and only about 20 per cent of the building has false ceilings. Most spaces including the auditorium, have ceiling fans.

> **If one looks at the building in totality it becomes clear that there is a strong relationship between the indoors and the courtyard.**

Materials like timber and bamboo, have been used in their natural condition and artificial colours have been consciously avoided. Hues like white, grey and brown dominate the palette. Glass partitions ensure natural lighting, and the converted semi shaded courtyard has a large photovoltaic (PV) solar roof. The building generates power from these 35 kW PV solar panels. A concrete *jaali* (latticed screen) modulates natural light and filters pretty patterns from the sunlight.

Creating out of waste

Most of the materials for the construction were sourced from within a 500 km radius and required very little processing energy to make them suitable for the building. We were partial to biomass materials like bamboo, teakwood, timber and rubber wood since these are easily renewable. Aluminium was banned because it consumes great amounts of energy in production.

Known for their sustainability, large quantities of granite and sandstone were favoured in the project. With a mantra of 'no wastage' the creative challenge was to move beyond the conventional. Tireless efforts were made to minimise wastage. The team created stone patterns very different from traditional geometrical shapes to help utilise the leftovers, giving the project a new dimension in design. Apart from stones, other waste materials like mirrors, broken tiles and plywood were imaginatively employed to fashion backdrops for the reception and the auditorium. Even leftover material from the lifts was used - at the entrance and on benches. The bricks in the building are made from the earth excavated for creating the basement. A portion of the well has been left uncovered to give visitors a glimpse of what lies beneath its shiny surface.

> **With a mantra of 'no wastage' the creative challenge was to move beyond the conventional.**

The IRRAD office is self sufficient with a pantry. Segregated biodegradable and non biodegradable dustbins on each floor leverage its sustainable model.

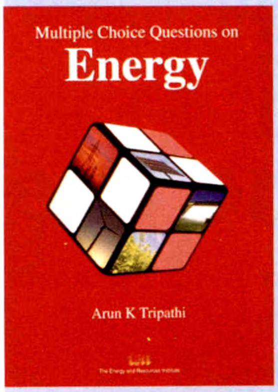
Concept and cost

Sustainable architecture is misunderstood, architects need to use their imagination to create new designs based on green principles. Since they are the experts on the impact of buildings on the ecology, it is their professional responsibility to practice sustainable design. A major part of sustainable designing is about common sense and only a small part deals with sophisticated technology. With intelligent designs such as the IRRAD building, electricity costs can be brought down by almost 50 per cent.

The IRRAD project costing of just Rs 20,000 to Rs 22,000 per sq m, rubbishes the popular belief that sustainable architecture is expensive. Sustainability assures 25-30 per cent reduced expenses in about five years. About 90 per cent of any sustainable project requires no extra expenditure, and may be constructed with even less - therefore the notion about high cost of green buildings is a complete myth. ✪

The author is Head, ABL Architects, New Delhi.

Multiple Choice Questions on Energy



Multiple Choice Questions on
Energy
Arun K Tripathi

Author: Arun K Tripathi
Soft bound: 338 pages
Size: 24cm. x 15cm.
Cover price: Rs 295.00 / USD 45.00
Publisher: TERI Press, New Delhi
Year: 2010
ISBN: 9788179933053

This book contains about 1300 multiple choice questions covering various sectors of energy. An introduction to energy has been presented in a comprehensive yet simplified manner. The book will be useful for academicians, students pursuing engineering or agriculture related courses, aspirants of various competitive exams, professionals and stakeholders in the energy sector. Is can also be used as a base for quiz programmes organised by schools, universities, and engineering institutions.

Energy is an integral part of our lives. We need energy to do all kinds of work. Though we do not realise it, energy is all pervasive. Human beings and animals derive their energy from food, which is prepared by plants using solar energy. Thus, the very basis of our lives is energy. Lots of energy was absorbed and released during the creation of the universe. Thus, it is energy that sustains the universe even today. Although the concept of energy is taught at the primary level and is included in various streams, it is rarely taught as an exclusive subject at the higher education level. In fact, the concept of energy is meant more for lifelong learning rather than studying as a subject. A few universities and engineering institutions have introduced exclusive degree courses on energy; however, technical books on energy need to be developed and made available commensurate with the latest developments. Since energy is such an important aspect of our lives, it needs to be paid due attention in education and awareness. This book attempts to present the subject in a simple and precise manner for students, aspirants of various competitive exams, and even laymen. ✪

TIRUPATI
The Green Temple

The temple in the south Indian state of Andhra Pradesh has gradually been introducing renewable energy along with the traditional ones at its facilities. Solar power is used for cooking; windmills meet some part of the temple town's power requirement; about 40-45 per cent of the energy required by Tirumala Tirupati Devasthanam (TTD) comes from its non conventional sources. A water recycling plant purifies all waste water for reuse in the temple city's gardens.

Tirumala Tirupati Devasthanam (TTD) is the richest temple in the world with the largest number of devotees visiting on any single day, is a fact that is well known. But perhaps few may be aware that it is also one of the temples in India that is slowly but surely becoming environment friendly.

The temple in the south Indian state of Andhra Pradesh has gradually been introducing renewable energy along with the traditional ones. Solar power is used for cooking, windmills meet some part of the temple town's power requirement; about 40-45 per cent of the energy required by TTD is coming from its non conventional sources. A water recycling plant purifies all waste water to reuse in the temple city's gardens. What is more, the canteen provides free mineral water through pipe lines to discourage use of plastic bottles.

The temple is also making a record of sorts as far as renewable technologies go. The largest solar cooker in the world was installed in the temples canteen in 2002. The system put up at the Nitya Annadanam complex at Tirumala has the capacity to prepare food for 15,000 persons at a time. Nearly 50,000 kg of rice along with *sambar* and *rasam* are cooked in the kitchens of Tirumala every day of the year without using conventional gas.

SOLAR TECHNOLOGY

The solar technology fixed at the temple's canteen is a scheffler parabolic dish installed by Gadhia Solar. The Gujarat based company is an innovative solar thermal energy company, focused on providing energy solutions using parabolic concentrated technology, backed by technical support from

HTT GmbH of Germany.

The technology deployed at Tirumala has the potential to generate temperatures of 500° C and more. The mechanism of conversion of solar to thermal energy is fundamentally similar to the traditional thermal system except that solar energy is used as the source of heat.

Using the power of the sun as a source of energy, Gadhia Solar has implemented some of the world's largest solar thermal systems in the last two decades. Be it industrial, agricultural, institutional or domestic, Gadhia Solar has been a pioneer with major breakthroughs in this area.

SOLAR COOKER AT THE CANTEEN

The solar steam cooking system at the temple canteen uses the Gadhia Solar Concentrating System for cooking using thermosyphon principle based on the natural convection principle. The solar dish concentrators convert water into high pressure steam, which cooks the food. The solar concentrators capture the solar radiation from all the directions possible at one point so that the total energy available is the maximum. Parabolic dish type collectors are generally used for generating steam at 8-10 bars from solar power. A mirror is used to concentrate sunlight on an insulated receiver placed at the focal point, which transfers heat from the receiver to water and generates steam. This steam generated from solar system is used for steam cooking application.

The systems automatic tracking systems follows the sun throughout the day. The system is hooked onto the existing boiler that works on diesel so that it can work under all climatic conditions. The solar cooking system is designed to generate over 4,000 kg of steam a day at 180° C and 10 kg/sq.cm, which is sufficient to cook two meals for around 15,000 devotees. Modular in nature, the system consists of 106 automatic tracked parabolic concentrators arranged in series and parallel combination, each with 9.2 sq.m reflector area. Each unit of concentrators is connected to a central steam pipeline going to the kitchen. The system is made of indigenous components and the reflectors are of acrylic mirrors having reflectivity over 75 per cent.

The total cost of the system is about Rs. 110 lakh, which includes back up boiler, utensils and annual maintenance contract for 5 years. Out of the total cost, the temple's share of expenditure was Rs. 63.5 lakh and the Ministry of New and Renewable Energy provided the rest as subsidy. This was under the demonstration scheme by the Central ministry. The maximum saving is around 450 lt/day (furnace oil), which adds upto Rs. 37,12,500 and the payback period is 2 years.

> **The solar cooker requires no plant modification and involves one time installation and relatively free running over a life span of 25 years.**

For developing the project, Gadhia hired the services of several qualified engineers. After the installation of the solar cooker was completed, a team from Gadhia conducted a workshop to provide training mainly to the users as this was a totally new system at the temple. At the workshop, details of operation and maintenance were explained. Prior to the solar cooker, firewood and LPG cylinders were the traditional energy sources for cooking at Tirumala. The over 4,000 kg steam generated per day by the solar cooker has replaced the usage of furnace oil which requires high amount of conventional source of energy.

The cooks at the temple's kitchen are the first in line to feel the benefit. According to them, their work now is easier and quicker. A huge improvement on the gas that took longer to cook. Now it takes just an incredible 20 minutes to complete cooking. As far as the impact on environment is concerned, the TTD has been saving an average of 450 lt of diesel per day resulting in a reduction of more than 1,350 kg of green house gas in the atmosphere. The use of solar cooker has also resulted in the decline of pollution in the area. It has created awareness about renewable sources of energy among the devotees who visit the temple and also in the nearby villages.

FUTURE PLANS

The TTD management plans to utilise the surplus steam generated by the solar plant to meet the requirements of Kalyanakatta - where on an average 10,000 pilgrims get their heads tonsured daily. Recently, in its efforts to reduce green house gas emission, the German Government was in the process of buying carbon credits from the solar kitchen of TTD. It identified the TTD kitchen as one of the projects from which it would buy certified carbon reductions (CERs). After installing the world's largest solar steam cooking systems at Tirupati and then at Shri Saibaba Sansthan at Shirdi and creating a solar crematorium, Gadhia has now developed the world's largest solar air conditioning system for the Muni Seva Ashram (MSA) in Goraj, Vadodara, Gujarat. ✪

Inputs from Access to Clean Energy, A glimpse of off-grid projects in India, published by MNRE, UNDP and SDC.

Greening through natural ventilation

The study highlights the application of natural ventilation for achieving thermal comfort in a high rise residential building.

By **Kiriti Sahoo and Minni Shastry**

Wind is a natural source of energy and research has shown that tapping the air flow can be a successful strategy for meeting the thermal comfort needs in buildings. The natural airflow induces cross ventilation in habitable spaces, evaporates sweat from the skin, brings a cooling effect in humid climates and helps in achieving a desirable thermal comfort for the inhabitants. The use of natural ventilation ultimately helps in reducing the demand on mechanical systems to maintain human thermal comfort. The Green Rating for Integrated Habitat Assessment (GRIHA) rating system addresses the requirement for human thermal comfort of naturally ventilated spaces for different climatic zones in India.

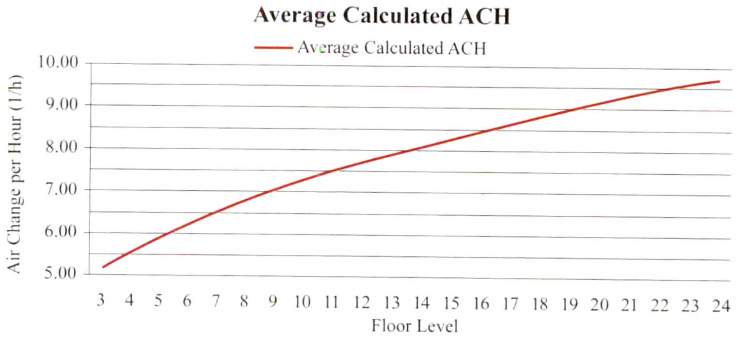
Requirement of GRIHA as per warm and humid climate

Criteria 14 of GRIHA, clause 14.1.7 emphasises on performing hourly calculations to meet two objectives:

1. Non air conditioned spaces in an apartment to meet thermal comfort for 60 per cent of all occupied hours.
2. Thermal comfort conditions should be compliant to the specifications as per National Building Code (NBC) 2005 (Bureau of Indian Standards (BIS) 2005d) for 60 per cent of all occupied hours.

The case study

A high rise residential building in the warm and humid climate zone of



Average Air change per hour achieved in living/family and dining space when windows are half opened

Table 1: Comparative table for simulated discomfort hours and GRIHA compliance

Occupancy schedule	Total discomfort hours achieved in the living/family cum dining room of each apartment (per cent)	Remarks
Day time schedule	5.96 to 12.26 per cent	GRIHA compliant
Night time schedule	0.00 to 0.41 per cent	GRIHA compliant
Evening time schedule	0.00 to 0.27 per cent	GRIHA compliant
24 hour time schedule	4.53 to 8.17 per cent	GRIHA compliant

Kolkata was chosen for the study. The height of the building was 90 m and the residential apartment units were located on the 3rd to the 24th floor level. The living space considered for the study was the living/family cum dining area of each apartment - an area of 48.25 sq m with a volume of 156 cubic m. The factors which were taken into consideration to calculate average probable indoor wind speed and average air change per hour in the space are: ■ Effect of the height and calculation of outside wind speed conditions for each apartment as per increasing height ■ Effect of window location and calculation of wind speed when a room had windows on two sides (opposite walls) ■ Effect of sill height of a window on wind speed ■ Effect of wind direction and window orientation ■ Effect of presence of veranda/balcony and wind speed calculation

Description of the indoor wind speed calculation

The wind speed obtained from meteorological data was used for calculating outdoor wind speed as per increasing height of each apartment from ground level. The calculated outdoor wind speed was used to calculate the probable indoor wind speed inside each living/family cum dining space. The indoor wind speed was calculated taking into consideration the effect of operable area (50 per cent) of window, sill height of window, position of window and orientation of wind direction and the presence of a balcony. The wind speed obtained varied from hour to hour on each floor. Hence, the average wind speed, which was calculated for 8,760 hours, was used to determine the ventilation rate and air change per hour.

Thermal comfort analysis as per GRIHA

Thermal comfort conditions, inside the space, were investigated using the calculated average air change per hour in the space due to wind conditions on site. The simulation was performed using Trnsys software. The thermal comfort analysis was then compared with the clause 14.1.7 of Criteria 14 of GRIHA and NBC 2005 (BIS 2005d). Hourly thermal simulations were performed in each of the 24 living/family cum dining family spaces. The results as per occupancy schedule were compared with GRIHA requirement (Table 1).

Conclusion

With increase of height above the ground, wind speeds also increase, this helps in integrating natural ventilation in high rise building structures. The simulation analysis showed that environmental conditions achieved inside the building chosen for the study are within the comfort band defined by NBC and the building also complies with the GRIHA rating system. ✪

The authors are, Research Associate and Associate Fellow, TERI, Bangalore, respectively.

Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that RE (renewable energy) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. Akshay Urja is an attempt to fulfil this need through the dissemination of 20,000 copies in India and abroad. The magazine publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photograph should be provided in high resolution files on a CD or through email. Akshay Urja wil pay a suitable honorarium to the authors for each published article of 1500 words and above The publication material in tw copies, along with a soft copy o CD/DVD/e-mail may be sent to

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What's that?

Here is an exercise that is intended to introduce green building material that can catch you unawares.

By **Mona Chhabra Anand**

Ferrocement (FC) building element

FC is a thin, versatile and strong cement based composite material. Made up of cement mortar and several layers of wire mesh with small diameter steel mesh closely bound together. FC elements consume lesser high energy material as compared to RCC. FC can be used for making wall panels, roofing elements, staircase treads etc.

Under-reamed Pile foundations

Under–reamed piles are suitable in filled up and expansive clays. Compared to RCC column foundations UR piles save about 2500 mega joules per column. They have a reduced pile shaft diameter, resulting in lesser use of concrete.

Fly ash blocks

Fly ash, lime and gypsum are the main raw material for these types of blocks. These are mixed homogeneously and compressed in CEB machine. Flyash bricks are air dried and are helpful in managing flyash which is a waste from thermal power plants.

Bamboo based building materials

In the current scenario of depleting forest cover and scarce wood resources, bamboo has emerged as a viable substitute for wood in building construction. Engineered bamboo has been successfully used for structural purposes as well as for production of composite materials and components such as bamboo boards which are aesthetically pleasing, cost effective and energy efficient.

Brick masonry in Rat trap Bond

This is constructed by placing bricks on edge with a void between the two layers of bricks intercepted at regular intervals by another brick on edge. It requires about 25 per cent lesser number of bricks and about 10 per cent lesser mortar leading to a saving of about 500 mega joules per cubic m of masonry. The wall has better insulation properties as compared to normal practice of Flemish or English bond.

Shotcrete

Shotcrete is used for strengthening of weak structures to increase their life. Hence it is a green building material / process. Compressed air forces mortar or concrete through a nozzle into the weak area of the element to be strengthened.

Compressed Earth Block (CEB)

CEBs have good thermal insulation, as well as more compressive strength as compared to country bricks. CEBs consume very less energy in production as the blocks gain strength by a combination of controlled curing and air drying.

Coir based wood substitutes

These are ideal choices, as biodegradable and eco-friendly substitutes to natural wood. Coir is used to manufacture lightweight, strong and aesthetically acceptable door shutters, panelling materials, ceilings and partitions.

Epoxy resins

Epoxy resins are used to bond two rigid materials such as two concrete surfaces. Thus these resins are used for retrofitting and strengthening of existing structures to increase their longevity. The viscosity of the resin can be chosen based on the size of the crack to be filled.

The author is Director, Knowledge Works, New Delhi.

Children's Corner

GREEN Detectives

Get your friends together, form a gang of greenies, go ahead and paint your school well, green.

Now you too can teach a thing or two to your teachers. Get your group of friends to investigate - how green is your school? You can single-handedly evaluate your school's environmental performance and save resources such as water, energy and waste material.

What you need:

The Team The first step is to form a team comprising 5-10 friends and a teacher facilitator who can help and guide you.

The Logsheets Prepare logsheets to note down data in a tabulated form. The three main logsheets that you will need are:

a. Tabulation of electricity points in each class, section, staff room, hall, office etc., for the Energy Investigator Team;
b. Lisitng of taps and flush in bathrooms, coolers and other water points for the Water Watch Team;
c. Listing of Kitchen, class dustbin, other waste such as leaves etc., for the Waste to Wealth Team.

You can keep adding other points, such as the number of trees in your school premises etc., as you get the hang of it.

Provisions Red marker pens, pencils, chalk to mark out leaking pipes etc., and tapes to stick Green Notices.

How to investigate:

Make a round of your school at break time every day. Collect floor wise, or item wise information on the three sections. Prepare a GREEN School Report Card with the help of your teacher. Here are the three important aspects that can be awarded marks by you during the evaluation.

Water: Put cross mark on each flush that is leaking, each tap that is leaking and more. Also measure and drain out the water cooler spillage into your school garden. Find out how much water is used everyday in your school by monitoring the overhead tanks.

Energy: Dig out electricity bills from the school office and unearth transport log books to find the units of electricity and fuel consumed in the school. Once your evaluation is in place, ask your school authorities to opt for certain energy efficient norms - such as using CFL, greening the sun facing walls, running ACs on 26°C and above, etc. Then review the bills in the next cycle, usually after 2 months.

Waste: Students can stay back after school time once a week and with the help of the housekeeping staff, measure the waste generated on that day. Help the staff to segregate waste into say paper, plastic and compostable. Maybe your teacher can help you with the composting and recycling options.

Apart from the above you can also collect information about various trees in your school by marking the trees. M-4 meaning Mango tree no. 4. You can have lots of fun finding out which is the oldest tree of the school.

The Green School Report Card:

The result is a 'Green School Report Card' prepared by its own students. The school comes to know where it stands on environmental sustainability and identifies areas of improvement - and works hard to improve the report card next year? Are you game...

Web/Book Alert

Website

Living with nature

http://thegreenguide.com

The Green Guide website, published by National Geographic provides interesting information and guides you towards greening your lives in a sustainable way. A free monthly newsletter with tests and scores that help reduce carbon footprints at the individual level is provided. Other issues, like sustainable travel, pollution free environs etc. are also discussed.

RE News India

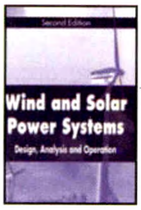
www.renewsindia.com

RE News India is a source for business news and upcoming opportunities in the renewable energy industry in India. If your business is targeting renewable energy products or services in the country, you will find useful information on the website. The subjects presently covered are focused on solar, wind, hydro, biomass, biofuel and geothermal energy. Each of these categories is further supported by India business news, upcoming business opportunities, tender news, job alerts and business offers.

World Green Building Council

www.worldgbc.org

The WorldGBC is a union of national Green Building Councils from around the world, making it the largest international organisation influencing the green building marketplace. Its mission is to be the global voice for Green Building Councils and to facilitate the global transformation of the building industry towards sustainability. The WorldGBC fosters and supports new and emerging Green Building Councils by providing them with the tools and strategies to establish strong organisations and leadership positions in their markets.



Wind and Solar Power Systems: Design, Analysis, and Operation, Second Edition

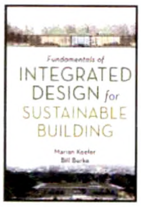
by **Mukund R Patel**

Hardcover: 448 pages
USD 129.54
Publisher: CRC Press
15 July 2005
ISBN: 0849315700
ISBN13: 9780849315701

Energy Efficient Buildings in India

by **Mili Majumdar**

Paperback: 252 pages
USD 80
Publisher: TERI Press
February 2009
ISBN: 8185419825
ISBN:13: 9788185419824, 978-8185419824



Fundamentals of Integrated Design for Sustainable Building: Principles and Practice

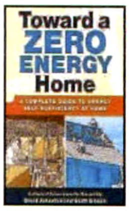
by **Marian Keeler and Bill Burke**

Hardcover: 416 pages
USD 85
Publisher: John Wiley & Sons
26 May 2009
ISBN: 0470152931
ISBN13: 9780470152935

Green Building Fundamentals Second Edition

by **Mike Montoya**

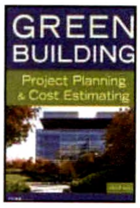
Paperback: 192 pages
USD 40.48
Publisher: Prentice Hall
16 January 2010
ISBN: 0135111080
ISBN13: 9780135111086



Toward a Zero Energy Home: A Complete Guide to Energy Self-Sufficiency at Home

by **David Johnston and Scott Gibson**

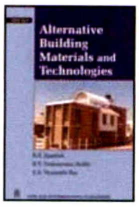
Paperback: 256 pages
USD 24.95
Publisher: Taunton Press, Incorporated
27 April 2010
ISBN: 1600851436
ISBN13: 9781600851438



Green Building: Project Planning and Cost Estimating Third Edition

by **R S Means**

Softcover: 480 pages
USD 99.95
Publisher: John Wiley & Sons
November 2010
ISBN: 0876292619
ISBN-13: 9780876292617



Alternative Building Materials and Technologies

by **KS Jagadish, BV Venkatarama Reddy and K S Nanjunda Rao**

Paperback: 218 pages
Rs 225
Publisher: New Age International
30 April 2009
ISBN: 8122420370
ISBN-13:9788122420371, 978-8122420371

Inputs from: various websites

National

18 to 20 May 2011	Workshop on Solar Thermal Power Plants Place: Gurgaon, India Organiser: IT Power Group Contact: 91 (124) 4305539 Website: www.itpowergroup.com
19 to 20 May 2011	Recent Trends in Materials and devices RTMD-2011 Place: Noida, India Organiser: Amity Institute of Applied Sciences, Amity University Contact: 91 9868639418 Website: www.amity.edu
24 to 25 May 2011	4th Renewable Energy Finance Forum - India Place: New Delhi, India Organiser: Euromoney Energy Events Contact: 44 (0) 2077798917 Website: www.euromoneyenergy.com
03 to 05 June 2011	International Conference on Society, Technology and Sustainable Development Place: Kochi, India Organiser: Department of Social Work, Amrita Vishwa Vidyapeetham Contact: 91 (476) 2801401 Website: http://amrita.edu
28 June 2011	Biofuels Industry: Technologies, Commercialisation and Policy Issues Place: New Delhi, India Organiser: Assocom-India and Kansas State University Contact: 91 (11) 47675201 Website: www.assocom-india.com

International

25 to 26 May 2011	2011 International Conference on Alternative Energy in Developing Countries and Emerging Economies Place: Hat Yai, Songkhla, Thailand Organiser: Research and Development Institute Thaksin University (RDITSU) Contact: 66 (74) 673227 Website: www.pt.tsu.ac.th
29 - 31 May 2011	Gulf Environment Forum Place: Jeddah, Saudi Arabia Organiser: BME Global Contact: 44 2033286522 Website: www.gulfenvironmentforum.com
30 May 2011	2011 International Conference on Green Building Technologies and Materials (GBTM 2011) Place: Brussels, Belgium Organiser: Asia-Pacific Association for the Advancement of Science (APAAS) Contact: 32 (499) 211599 Website: www.gbtm2011.org
31 May - 03 June 2011	ISWA WasteTech Conference Place: Moscow, Russia Organiser: SIBICO International Ltd Contact: 7 (495) 2255986 Website: http://2011.sibico.com
02 - 05 June 2011	ACSEE - The Asian Conference on Sustainability, Energy and the Environment 2011 Place: Osaka, Japan Organiser: International Academic Forum (Japan) Contact: acsee@iafor.org Website: http://acsee.iafor.org
05 - 09 June 2011	International Green Energy Conference-VI (IGEC-VI) Place: Eskisehir, Turkey Organiser: IGEC-6 Contact: igec6@anadolu.edu.tr Website: http://igec6.anadolu.edu.tr
09 - 11 June 2011	International Student Energy Summit 2011 Place: Vancouver, Canada Organiser: University of British Columbia Contact: info@studentenergy.org Website: www.studentenergy.org

Renewable Energy at a Glance

Cumulative deployment of various renewable energy systems/devices in India

Renewable energy Programmes/systems	Cumulative achievements (as on 31 March 2011)
1. Power from renewables	
A. Grid interactive renewable power	**In MW**
Wind power	14156.00
Small hydro power (up to 25 MW)	3042.63
Biomass power (Agro residues and plantations)	997.10
Bagasse cogeneration	1667.53
Waste to power (Urban and Industrial)	72.46
Solar power	37.66
Sub total (A)	**19973.38**
B. Off grid/ distributed renewable power including captive/CHP plants	
Biomass Cogeneration (Non-bagasse)	301.61
Biomass gasifier	131.81
Energy recovery from waste	70.42
Solar PV power plants	8.16
Watermills/microhydel	6.98
Sub total (B)	**518.98**
Total (A+B)	**20492.36**
2. Decentralised renewable energy systems	
Family type biogas plants (in lakh)	44.04
Solar photovoltaic systems	
Street lighting system (in nos.)	1,82,200
Home lighting systems (in nos.)	7,33,245
Solar lanterns (in nos.)	8,31,604
Solar water heating systems-collector area (m^2)	4.47 million m^2
3. Remote Village Electrification (villages/hamlets)	**8104**

kW= kilowatt; MW = megawatt; Sq m = square metre

Volume 4 ■ Issue 6 ■ June 2011

सत्यमेव जयते

try of New and
ewable Energy
ernment of India

Renewable Energy

Akshay Urja

www.mnre.gov.in

31/8/11

- **Roshni**
- **Towards a future of renewables**
- **Hybrid energy systems in telecommunication**
- **Bio-diesel from microalgae**

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Energy And Environment Founda

WORLD RENEWABLE ENERGY TECHNOLOGY CONGRESS

Third International Conference and Exhibition

25-27 April 2012 at New Delhi, India

Organised by

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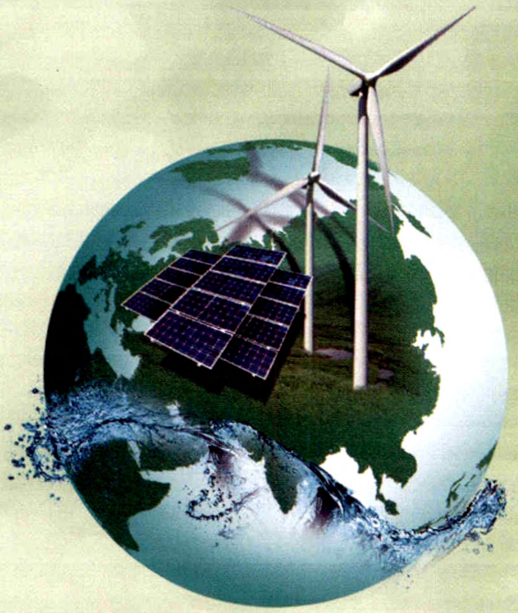
FOCUS ON THE FUTURE



Second World Renewable Energy Technology Congress and Expo held at Hotel LeMeridien New Delhi from 21st to 23rd April 2011 was a grand success. The congress was attended by 325 delegates, dignitaries and speakers from 33 countries.

The most inspiring international platform for the global renewable energy sector

Join us at WRETC 2012, our third annual conference and exhibi
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and address industry developments in renewable energy se

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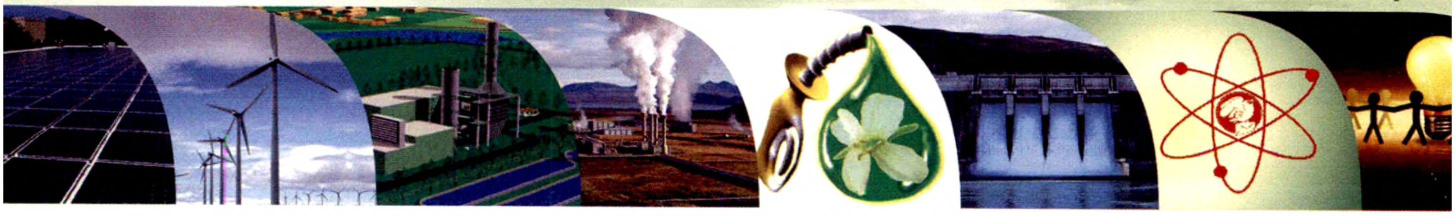

WRETC Secretariat
F1-F2, Pankaj Grand Plaza, CSC Complex, Mayur Vihar-I, Delhi-110091, India • Tel: +91 11 24538318. Fax: +91 11 43019379

Dr. Anil K Garg, President - World Renewable Energy Technology Congress & Expo-2012
Cell : +91 9971500028 / 9999071071 / 9910135500 • E-mail : dranilgarg2011@gmail.com, dranilgarg@wretc.in

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Renewable Energy
Akshay Urja

Volume 4 ▪ Issue 6
June 2011

A bi-monthly newsletter of the Ministry of New and Renewable Energy, Government of India
(Published in English and Hindi)

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Produced by
Iris Publication Pvt. Ltd.
111/9 KG, Aruna Asaf Ali Marg,
Vasant Kunj, New Delhi -110 070
Telefax. +91 11 2612 2789, 2689 2275
E-mail: ipplimited@yahoo.co.in
Web: www.geographyandyou.com

Publisher and Printer
Ministry of New and Renewable Energy, New Delhi

Cover Photos: The President of India, Smt. Pratibha Devisingh Patil inaugurated Roshni - an environmental initiative on 19 May 2011.

Disclaimer: The views expressed by authors including those of the editor in this newsletter are not

From the Editor's Desk

Dear Readers,

Everything in this world moves due to energy only. Energy is an important indicator of the development and prosperity of a country. India's primary energy supply was about 18.1 EJ in 2007 being 19 per cent that of the USA and 25 per cent that of China. If India continues the sustained economic growth, achieving 8-10 per cent of gross domestic product (GDP) growth per annum through 2030, its primary energy supply will need to grow by 3 to 4 times and electricity supply by 5 to 7 times of today's consumption.

The recent 62nd report of the National Sample Survey Organisation on Household Consumer Expenditure in India reveals the fact that in rural India 74 per cent of households continued to depend on firewood and chips as their major cooking fuel, about 9 per cent used dung cake and only 9 per cent have access to LPG. This reveals that a large section in India i.e. rural area still depends on the traditional biomass. In this scenario, renewable energy could be an option to the rural energy problem.

Today renewable energy is no longer an 'alternate energy', but increasingly it has become a key part of the solution to the nation's energy needs. Now, renewable energy is an important component of India's energy planning process. With installation of over 19000 MW renewable powers, it contributes to about 11 per cent in the total installed capacity of power from all sources in the country. This could be possible due to the conducive policies of the Ministry of New and Renewable Energy.

In this context, this issue is an attempt to provide information about the development of renewable energy in various fields. Biogas bottling is an attempt to enhance the utilisation of biogas in many other fields. Telecommunication industry is also looking towards a solution of continuous power supply in rural areas. Hydrogen energy is being looked at as a future energy solution. The present issue has information on these aspects and I am sure that you all will like it. Please do send your views and suggestions to make Akshay Urja a most favourite publication for all.

Happy reading.

अक्षय ऊर्जा से देश विकास

ARUN K TRIPATHI
<aktripathi@nic.in>

Published, printed and edited for and on behalf of the Ministry of New and Renewable Energy, Government of India, from B-14, CGO Complex, Lodhi Road, New Delhi, by Dr Arun Kumar Tripathi. Printed at Aravali Printers & Publishers (P) Ltd. W-30, Okhla Industrial Area, Phase II, New Delhi - 110 020, India

Letters to the Editor

I am a regular reader of Akshay Urja and enjoy the innovative ideas of renewable energy systems covered in the newsletter. I appreciate the skill and creativity in this wonderful endeavour.

Suresh Dodia,
Rajkot, Gujarat

Recently I had the opportunity to go through your publication Akshay Urja. I am highly impressed by its rich content in the field of solar energy - a topic very close to my heart.

B Ramesh Adiga,
Manipal, Karnataka

We are very much thankful to the Ministry of New and Renewable Energy for regularly sending us the newsletter Akshay Urja that covers various developments and research updates in the field of renewable energy. Our organisation is making all efforts to take the innovations to the masses and to improve the understanding of the present energy scenario in our area. Please note our new address and kindly continue to send us the newsletter.

A S Rakshasbhuvankar, Secretary,
Urja Sahyog, Aurangabad,
Maharashtra

I was highly impressed with the informative and interesting contents of your newsletter Akshay Urja, which I read through in the house of a friend. I would like to read the newsletter regularly and therefore request you to kindly add my name and address to your mailing list.

Krishan K Sharma,
Jammu, J&K

It is a pleasure to acknowledge that Akshay Urja newsletter is very informative and a good educator, particularly for people like us who live in villages and can use solar energy effectively. We appreciate your great endeavour. We are grateful and request you to keep us updated on the use of renewable energy through Akshay Urja.

M R Kishore
Varanasi, Uttar Pradesh

We are regular subscribers of Akshay Urja and would like to take this opportunity to appreciate your excellent efforts to publish all hot topics on renewable energy from all across the country. Our company is 26 years old in the solar industry and we have developed an innovative solar package, which suits the needs of educational institutions.

K R Jagadeesh Babu,
General Manager, Solkar Solar
Industry, Chennai, Tamil Nadu

We have found Akshay Urja to be a very useful and informative newsletter. The subjects and topics covered are comprehensive and up to date. As one of the reputed consultancy house in Orissa, we desire to share this information with our clients, NGOs and individuals for spreading the knowledge relating to RE technology and the current trends. We therefore request you to send the newsletter to us regularly.

Bibhu Swain, Sr Consultant,
Power Tech Consultant,
Cuttack, Orissa

I work in the Renewable Energy Department of CTAE College, Udaipur. I assist the BE, ME and PhD students with their projects for which the Akshay Urja bi-monthly newsletter would be extremely beneficial. I therefore request you to kindly send the newsletter at my residential address given herewith.

Dinesh Kr Agarwal,
Udaipur, Rajasthan

आपकी मासिक पत्रिका निरन्तर इसी प्रकार महाविद्यालय में प्राप्त होती रहे जिससे आदिवासी क्षेत्र के अध्ययनरत छात्र/छात्राओं को उत्कृष्ट ज्ञान प्राप्त हो सके। इसी आशा एवं विश्वास के साथ सम्पूर्ण महाविद्यालय परिवार की ओर से अक्षय ऊर्जा टीम को हार्दिक धन्यवाद।

डॉ. आर. के. गौतम, प्राचार्य,
स्वामी द्वारका दास कला एवं वाणिज्य
महाविद्यालय, ढीमरखेड़ा, मध्य प्रदेश

शासकीय कला एवं वाणिज्य महाविद्यालय कोहका–नेवरा जिला रायपुर छत्तीसगढ़ राज्य के ग्रामीण क्षेत्र में स्थापित है। यहां पर लगभग 600 छात्र–छात्राएं पढ़ते हैं। आपसे निवेदन है कि आपके विभाग द्वारा प्रकाशित 'अक्षय ऊर्जा' पत्रिका की निःशुल्क प्रति भेजें। निःसंदेह यह पत्रिका विद्यार्थियों के लिए लाभान्वित होगी।

प्राचार्य, शासकीय कला एवं वाणिज्य
महाविद्यालय कोहका–नेवरा, छत्तीसगढ़

Dear Reader, Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvements in terms of content and presentation. **Editor: Akshay Urja**

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- US keen to explore solar energy options in Punjab
- Advanced biofuel to meet over 50 per cent of India's transport demand
- Dow Corning announces Global Wedge as Solar Solutions Distributor in India
- MNRE and the Australian Government release the CSP report
- Lanco Solar to build 75 MW Solar PV project in Maharashtra
- Phadnis Group plans expansion

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India needs a clean and renewable source of energy, for which offshore wind power can play a major role. Prospects of offshore wind power in India thus need exploration.

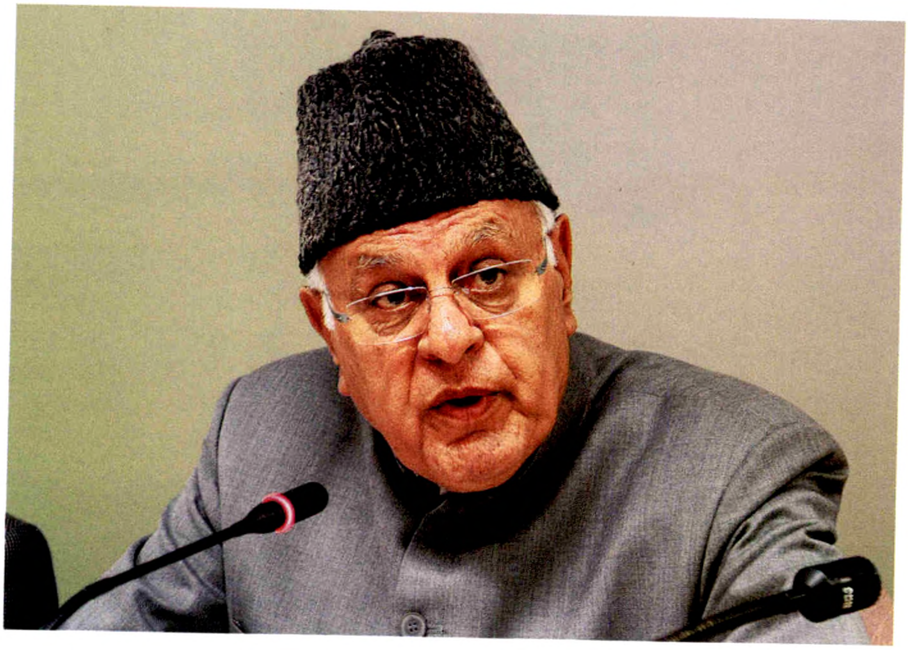
More than 86 per cent of rural households in India use traditional less efficient *chulhas* which cause serious problems for human health and environment.

Chandigarh Electricity Department is to develop roof top solar power facility. The study examines the feasibility of setting up a 1 MW roof top solar power project.

India to host International Centre on Energy Access

India offered to set up an international centre on energy access to boost the provision of energy to remote and inaccessible areas. The offer was made by Dr Farooq Abdullah, Minister for New and Renewable Energy. Dr Abdullah was speaking at the inaugural session of the assembly of the International Renewable Energy Agency- IRENA held at Abu Dhabi, UAE. The worlds first intergovernmental agency on renewable agency was established in 2009 with the main objective of fostering international cooperation and promoting international understanding on renewable energy. India has been associated with the formation of IRENA from the beginning and was among the first 25 countries to ratify its statute. Making a strong pitch for the use of renewable energy, Dr Abdullah emphasised that renewable energy is the only hope for the future. However, in order to make it the preferred energy worldwide and to scale up the use of renewable energy in the energy mix, the nations of the world need to cooperate more and share information, technology and best practices. This will be necessary to bring energy access to vast areas of the world, which have yet to experience the fruits of commercial energy. He spoke of India's large size, considerable experience and a vast pool of technically qualified personnel and offered India's expertise in building and hosting, in cooperation with IRENA, a Centre on Energy Access in India. This centre will serve as Centre of Excellence in the field of energy access through the use of renewable energy. He also offered to host an international conference on energy access later this year to bring this idea to fruition. He also announced the scaling up of India's international programme on capacity building and to share expertise and best practices with developing countries.

http://pib.nic.in, 05 April 2011



OIL and TERI sign agreement

Oil India Limited (OIL) signed a ten year memorandum of understanding (MoU) with The Energy and Resources Institute (TERI) to broaden the scope of joint research collaboration in areas of petroleum biotechnology and new and renewable energy sources. The MoU was singed by Mr B N Talukdar, Director Exploration and Development, OIL and Mr M M Joshi, Director Technology Dissemination and Enterprise Development, TERI.

www.businesswireindia.com, 25 April 2011

Tata Power commissions 3 MW solar power plant in Maharashtra

Pursuant to the Company's objective of building a robust renewable energy portfolio that is 20-25 per cent of its total generation capacity, Tata Power, announced the Commercial Operation of its 3 MW, photovoltaic (PV) based, grid connected solar power plant at Mulshi, Maharashtra. The plant achieved Commercial Operation in March 2011. This is the first and largest solar (PV) power plant in the State of Maharashtra and one of the largest in the country. The plant is spread over 12 acres of land and is situated near Pune.

The energy produced from the 3 MW Solar plant in Mulshi will be purchased by Tata Power- Distribution in Mumbai to meet the RPO as per MERC guidelines. Tata BP Solar is the technology provider for the project. The project is Tata Power's and Tata

BP Solar's novel experience in building, operating and maintaining a megawatt-scale grid connected solar power plant in India. Given the modular nature of the system, the project was executed in 9 months.
www.worldofrenewables.com, 28 April 2011

No need for environmental nod for solar PV plants

India's Ministry of Environment and Forests (MoEF) has exempted the solar photovoltaic (PV) farms coming up in the country from having to seek environment clearance. India is in the midst of a massive programme to increase its grid connected solar power generation capacity from around 20 million watts at the end of the 2010 to 20,000 million watts by 2022. The addition is expected to comprise of PV farms - the typical solar installation - and other technologies like thermal or steam and turbine based solar farms.

The exemption from seeking environmental nod and creating environment impact reports etc. is likely to keep the Solar Mission on schedule. Green nods can be taken anywhere from 2 months to a year. The clarification by the environment ministry, headed by Jairam Ramesh, was done after a query was raised by the Ministry of New and Renewable Energy. Most of the new solar farms, both PV and thermal, are being set up by small firms, primarily land developers and are concentrated around India's Thar desert. It is estimated that a fraction of the Thar desert, covered by solar panels, may be enough to meet India's power needs. Under the current scheme, the maximum size of the plant to be included in the programme is only 5 MW, to ensure the broadest participation from the industry.
http://rtn.asia, 16 May 2011

Eco-friendly bike

The world's first eco-friendly bike was unveiled in Pune by Ayub Khan Pathan, an electrician, who along with his co-workers, successfully made the solar bike, which runs on solar power. Speaking to reporters, Pathan said that after three months of hard work, the bike is finally ready to hit the roads. The bike's mechanical parts have been transformed in a way to enable it to run on solar rays, making it noiseless and pollution free. He said that with the increase in petrol prices, the bike is a perfect alternative as it contains solar rays DC panel and DC supply with a battery charger.

With a button start, the bike can cover up to 50 to 60 kms without energy fuel. Its average will be up to 200 to 250 kms during the day as the battery gets fully charged. In case of cloudy weather, the bike batteries can be charged with a multi purpose socket, he said. The price of the bike is currently Rs 26,000 and may decrease to Rs 16,000, after large scale production is undertaken.
www.centralchronicle.com, 16 May 2011

US keen to explore solar energy options in Punjab

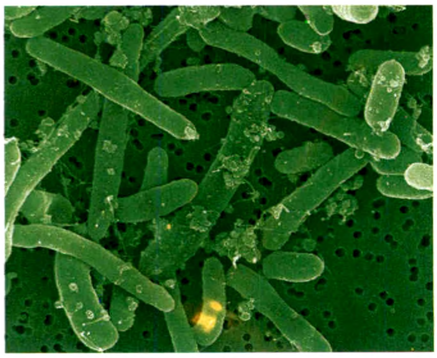
The United States has expressed interest in exploring promotion of solar energy options in Punjab. Greg O'Connor, Commercial Counsellor at the US Embassy in New Delhi said Washington is keen to promote bilateral cooperation in the alternate and renewable energy sector, and added that American firms are ready to set up units in partnership with industries in Punjab and in other parts of India. Representatives of American firms were in Punjab to learn about the commercial aspects and the opportunities available to them.

Suneet Kochar, district president of the Confederation of Indian Industry, said that the visit by the American delegation should be seen as an opportunity for Punjab. He said that till a few years ago, the business environment in Punjab was dismal, and such business opportunities as being provided by the United States, would certainly boost industrial and business confidence in the state.
http://economictimes.indiatimes.com, 19 May 2011

Advanced biofuel to meet over 50 per cent of India's transport demand

Transforming agricultural waste into biofuel could create up to one million jobs in India over the next decade while radically improving India's energy efficiency by meeting up to 59 per cent of the demand for transport gasoline through greener fuels by 2020, according to a new study. The Indian Government has already announced an ambitious target of 20 per cent of biofuels in transport by 2017 as part of its Indian Biofuels Policy.

The Bloomberg New Energy Finance study "Next-generation Ethanol: What's in it for India" commissioned by Novozymes, the world leader in bioinnovation and industrial enzymes, was presented at an event organised under the aegis of the Danish Embassy in India in cooperation with the Ministry of New and Renewable Energy. According to the report, biofuels from agricultural residues are a critical existing alternative to liquid fuel which is not only environmentally sustainable but offers huge potential and thus needs to be pursued aggressively. Unlocking the Indian biomass potential would create around a million aggregated jobs between 2010 and 2020, thus providing the much required impetus for inclusive growth by providing employment in rural India.
www.commodities-now.com, 18 May 2011



Dow Corning announces Global Wedge as Solar Solutions Distributor in India

Global Wedge, a distributor of photovoltaic (PV) raw materials, solar modules and panels, and a developer of solar power projects since 2001, will supply high quality silicone solutions to Dow Corning's customers in India. Located in Hyderabad, India, Global Wedge has an excellent reputation as a PV materials supplier and an extensive customer base in India.

"India continues to grow as an economic powerhouse, and the solar industry with it. We are excited about the prospect of providing solutions to the Indian solar power industry to support its expansion," said Allison Ashbrook, global distribution manager, Dow Corning Solar Business. "We look forward to working with Global Wedge in India and with our broad network of regional distributors throughout the Asia-Pacific region to provide silicone solutions that will help solar energy become a viable energy option."

"We are excited to be associated with Dow Corning as a distributor for India," said Rao Marella, President, Global Wedge.
www.dowcorning.com, 19 May 2011

MNRE and the Australian Government release the CSP report

The world is in the middle of an energy revolution. This revolution is driven by concerns about greenhouse gas emissions, but even more by the unequal equation of growing demand for oil, reduced rates of discovery and consequently inevitably increasing prices. Concentrated Solar Thermal Power technologies are at a key moment in their history. Whilst they have been in commercial operation for over 20 years, there has been little growth until 2006 when we entered a new phase. Realising the potential of solar energy, the Indian Government has launched the ambitious Jawaharlal Nehru National Solar Mission (JNNSM) which is likely to catapult India into becoming the largest market for solar energy in the world.

With India poised to become the lead market in sustainable energy solutions, there is a massive skills shortage that is hampering progress in this sector. To cater to the industry's need of the hour, IT Power Group, a leading international energy consultancy in the sustainable energy sector conducted a three day technical workshop on Concentrated Solar Power Plants (CSP) that witnessed an unprecedented gathering of thought leaders from the public and private sector. Supported by the Ministry of New and Renewable Energy (MNRE) the workshop took place from 18 - 20 May 2011, at the Claridges Hotel, New Delhi.

Among the many highlights was the launch of the highly anticipated CSP report that was commissioned by the Australian Government's Department of Climate Change and Energy Efficiency and authored by the IT Power Group.

www.indiaprwire.com, 26 May 2011

Lanco Solar to build 75 MW Solar PV project in Maharashtra

Lanco Solar, a fully owned subsidiary of Lanco Infratech Limited has announced that it, in consortium with Juwi Renewable India Ltd, has received a letter of award (LOA) from Maharashtra State Power Generation Co Ltd (Mahagenco) for building of a 75 MW crystalline technology based photovoltaic solar power project in Dhule district in the state of Maharashtra. The project value is Rs. 8.84 billion. The project would be fully commissioned by mid February 2012.

L Madhusudhan Rao, Chairman, Lanco Group, said, "India's solar power generation capacity will reach 68,000 MW by 2021-22, triple the government's target. To pursue the same, we at Lanco have given utmost importance to build on capacities in solar power generation which is also the need of the hour and aim to have 300 MW in generation in the next two years. In engineering, procurement and construction (EPC) we aim to have 300-500 MW of solar thermal and solar PV plants over the next couple of years".

"This pioneering initiative by Mahagenco and Government of Maharashtra reinforces India's position as a fast growing solar market globally along with the commendable initiatives of MNRE under the National Solar Mission. It would also considerably help in attracting new industries and talent into this space to reduce installation costs and help the country in its solar agenda" added Mr V Saibaba, CEO, Lanco Solar.

www.indiainfoline.com, 26 May 2011

Phadnis Group plans expansion

In the area of power generation, Phadnis Group is looking at 10 MW solar power generating capacity across India. Also, it is setting up a 2 MW solar power plant in Maharashtra's Beed district for which it has entered into an agreements with Maharashtra Energy Development Authority (MEDA).

www.business-standard.com, 28 May 2011

REACH compliance

REACH is the Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals. It streamlines and improves the former legislative framework on chemicals of the European Union (EU). The main aims of REACH are to ensure a high level of protection of human health and the environment from the risks that can be posed by chemicals, the promotion of alternative test methods, the free circulation of substances on the internal market and enhancing competitiveness and innovation. REACH makes industry responsible for assessing and managing the risks posed by chemicals and providing appropriate safety information to their users.

REACH is one of the most complex regulations to affect companies involved in importing and transporting biofuels within the EU. To achieve REACH compliance any company involved in the sector will need to rethink the way in which they send safety data sheets (SDSs) to customers, as the legislation now insists they are responsible for sending them directly to customers. Failure to do so could result in legal action. Any company shipping and distributing chemicals to and within the EU will need to ensure the direct delivery of SDSs and associated documentation to their customers. They will also be responsible for keeping these documents, and their customers, up to date in the event of any changes or clarifications.

Biofuels International, Vol 5, Issue 3, May 2011

Shelling out on biofuels

Shell is the world's biggest distributor of biofuels. Last year alone the oil giant distributed 9.5 billion litres of the renewable fuel and has no plans to stop there. The company has laboratories around the world in places such as Chester, UK; Amsterdam, The Netherlands; Houston, US; and Bangalore, India; and has plans to open more. Although the company is unable to disclose how much it invests into biofuels specifically, its total research and development spend in 2010 was USD 1.3 billion and, according to Jeremy Shears, Shell's global manager for biodomain, a 'significant part of that goes towards biofuels'. Why biofuels? Over the next 40 years there is going to be a drastic rise in the consumption of energy, with the demand expected to double, especially in developing economies. To cope with this, there

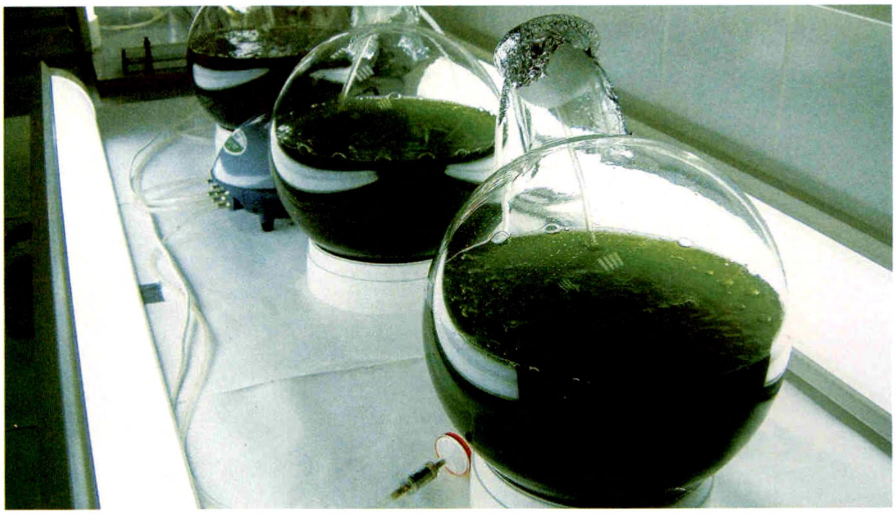
needs to be a 'diverse and secure supply of energy', says Shears. The transport sector accounts for a quarter of the emissions the world produces. Cutting greenhouse gases is one reason why Shell wants to increase its biofuels distribution, although the company also recognises a growing demand for the fuel. New legislation in different regions around the world has sparked the push into biofuels development, such as in the EU wher the European Union Renewable Energy Directive wants to see 10 per cent of all road vehicle fuel come from biofuels by 2020. In the US, the Energy Independence and Security Act 2007 also stipulates 36 billion gallons of road transport fuels should be renewable by 2022.

Biofuels International, Vol 5, Issue 3, May 2011

Global algal fuel market

With the advances in technology, it has now become possible to generate fuel from even the trash tha you throw out on a daily basis. One such novel innovations of technolog in the recent years has been the capability to produce fuel from the common pond scum - or algae. In the last couple of years, algae has caught the interest of researchers worldwide because of its ability to b used as biofuel. The potential of alga as a source of biofuel is tremendous, particularly because of the exponent growth rate that algae has. It has the capacity to double in quantity almost overnight and it can be harvested on a daily basis. Not to mention the fact that harvesting algae as biofuel takes away the many challenges posed by food crops that are being harvested for biofuels today. In a scenario where energy demands, particularly for transportation, are increasing on a daily basis, the potential of algae to be turned into fuel is being touted as the next big thing in the energy industry, with supporters already hailing algae as the fuel of the future. In this industry landscape, Taiyou Research presents an analysis of the Global Algal Fuels Market. With the race on around the world for commercialising algae as a source of fuel, Taiyou Research focuses on the aspects of algal fuel that makes it such an attractive option for investors today. This research report - Global Algal Fuels Market - is a complete analysis of the global algal fuel market and is available at: www.researchandmarkets.com.

www.worldofrenewables.com,
6 May 2011



Solar plane takes first international flight

Solar energy has started to carve out a role in power production and has always had a niche in consumer products, but one group is making the case for solar power in transportation. The one-man plane Solar Impulse took off from Geneva, Switzerland on the first ever solar powered international flight.

Solar Impulse is a project of the École Polytechnique Fédérale de Lausanne in Switzerland, which seeks to promote a push toward pollution free travel. The plane has been under development for more than seven years, but has progressed rapidly from its first flight last April to its first overnight flight last July. The plane is only a little more than 70 ft long, but boasts a wingspan of 208 ft. The wings and horizontal stabiliser hold more than 11,000 solar panels powering four 10 horsepower engines, allowing the plane to reach an average speed of around 44 miles per hour. After its flight to Belgium, which is expected to take around 12 hours, Solar Impulse will be presented at the Paris Air Show this June, which is scheduled to include flying demonstrations.

http://solar.coolerplanet.com,
13 May 2011

Green energy sparks Tibetans' daily lives

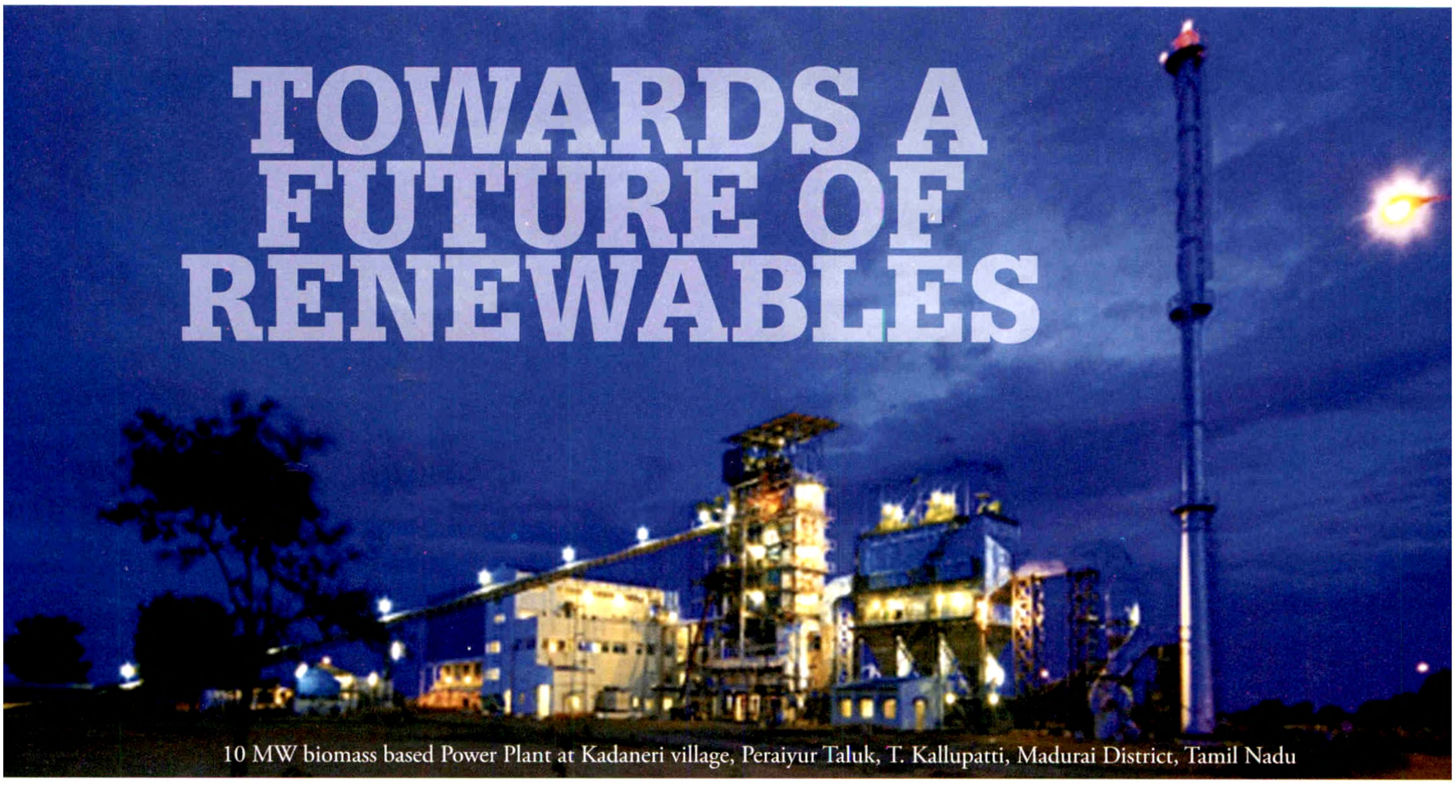
When Lhapa puts his hands on the steering wheel and cannot turn his prayer wheel, solar energy turns the prayer wheel for him. Powered by a 4 cm long, 2 cm wide solar battery, a 15 cm high golden prayer wheel mounted to the dashboard steadily whirls and sends out prayers to the Buddha. "It is very cheap, 30 yuan (USD 4.4). You can buy it at any booth on the street", said Lhapa, who lives in Lhasa. "You will find solar power everywhere in Lhasa", he added.

In a neighbourhood in Lhasa's western suburb, almost every courtyard home is equipped with a solar powered water heater. "When I was young, people did not shower very often because we did not have enough fuel to heat water. Now, with the solar powered water heater, I can do it every day", said Kelsang Namgyal, a man in his late fifties who grew up in a farmer's family. He also installed a solar powered stove in his courtyard. "The stove is much more efficient than the old stove fuelled by dried yak poo. It takes about 20 minutes to braise beef", he said. About 395,000 solar powered stoves have been used by Tibetans, according to the government.

In recent years, Tibet has been working to develop and implement green energies such as solar, wind and biofuels. "Tibet has the richest solar energy in China and one of the richest in the world. The region receives about 3,000 hours of sunshine annually on average", said Ma Shengjie, director of the science and technology department of the Tibet Autonomous Region Government. "With the government's efforts in the past few years, Tibet has led the application of solar energy in China", Ma said.

http://news.xinhuanet.com,
19 May 2011

TOWARDS A FUTURE OF RENEWABLES



10 MW biomass based Power Plant at Kadaneri village, Peraiyur Taluk, T. Kallupatti, Madurai District, Tamil Nadu

The growing demand for energy makes it imperative to harness all available renewable resources in India. Renewable energy (RE) is no longer an 'alternate energy', it is increasingly becoming a key part of the solution to the nation's energy needs.

Dr Arun K Tripathi

Economic development has strong correlation with the energy utilisation in a country. India has seen a growth rate of 9 per cent and 9.2 per cent in the Gross Domestic Product in 2005-06 and 2006-07 and the present growth rate is of about 8 per cent. The Eleventh Plan has envisaged the growth of the Indian economy at 9 per cent, thereby a commensurate growth in energy is also envisaged. India imports about 74 per cent of its oil. There is a threat of this increasing further, creating serious problems for India's future energy security. India's substantial and sustained economic growth is placing an enormous demand on its energy resources. The demand and supply imbalance in energy sources is pervasive requiring serious efforts by the Government to augment energy supplies. The country thus faces possible severe energy supply constraints.

Economic growth, increasing prosperity and urbanisation, rise in per capita consumption, and spread of energy access are the factors likely to substantially increase the total demand for electricity. In the last six decades, in spite of substantial increase in installed electricity capacity in India, demand has outstripped supply. Thus, there is an emerging energy supply-demand imbalance. Already, in the electricity sector, official peak deficits are of the order of 12.7 per cent, which could increase over the long term. In the real sense, if we take into account the 24x7 supply of electricity in the whole country including rural areas, the peak deficit may be about 3 times more. Due to this shortage, enormous diesel and furnace oil are being used by all sectors – industrial, commercial, institutional or residential. Lack of rural lighting is leading to large scale use of kerosene.

More than 50 per cent of the population has little or no access to commercial energy for their living and livelihood. Others with access often have to cope with poor and erratic availability of electricity and other fuels. With constraints faced in resource availability and in delivery mechanisms, traditional means of energy supply are falling short. This is likely to be the case in the foreseeable future so that energy access will continue to remain a problem.

Role of Renewable Energy

The above situation makes it imperative to harness the renewable energy resources wherever and whenever possible. Renewable energy (RE) is no longer 'alternate energy', but will increasingly become a key part of the solution to the nation's energy needs. In fact, a beginning has already been made and it is an important component of India's energy planning process now. It has the potential to resolve the decentralised energy needs of the remotest corner of the country.

Renewable Energy Infrastructure

At the Government level, political commitment to renewable energy manifested itself in the establishment of the first Department of Non-Conventional Energy Sources in 1982, which was then upgraded to a full-fledged Ministry of Non-Conventional Energy Sources (MNES) in 1992 and subsequently renamed as Ministry of New and Renewable Energy (MNRE). Today, all 28 states and 7 union territories (UTs) have nodal departments/agencies which are exclusively implementing the renewable energy programmes/schemes of the MNRE in their respective states/UTs. The MNRE has four specialised institutions, namely Solar Energy Centre at Gurgaon (for solar energy), Centre for Wind Energy Technology at Chennai (for wind energy), Sardar Swarn Singh National Institute of Renewable Energy at Jalandhar and Indian Renewable Energy Development Agency (financial institution) at New Delhi.

Many prime engineering institutions like Indian Institutes of Technologys (IITs), National Institute of Technologies (NITs) and national level laboratories have been conducting the basic as well as applied research and development (R&D) work in the country. This has resulted in development of many end use renewable energy systems and devices like, solar water heaters, solar lighting systems, solar cooking systems, solar space conditioning, solar power plants, biogas plants, biomass gasification based electrical thermal and mechanical systems, biomass based power plants, wind power, small hydro power etc. Most of these technologies are commercially available in the country in the open market.

> **Several new initiatives have been taken by MNRE to make renewable energy affordable t the common mass and to meet their electricit and energy needs all over the country.**

The Activities of MNRE

The MNRE has been facilitating the implementation of broad spectrum programmes including harnessing renewable power, renewable energy to rural areas for lighting, cooking and motive power, use of renewable energy in urban, industrial and commercial applications and development of alternate fuels and applications. The endeavour of the Ministry is to promote renewable energy (RE) utilisation, develop affordable RE technologies and increase the contribution of RE in the total energy mix, today and in the years to come.

The Ministry adopts a three fold strategy (i) providing budgetary support for research, development and demonstration of technologies; (ii) facilitating institutional finance through various financial institutions; and (iii) promoting private investment through fiscal incentives, tax holidays, depreciation allowance and remunerative returns for power fed into the grid. The MNRE has been supporting renewable energy development through an attractive mix of fiscal and financial incentives. These include capital/ interest subsidy, accelerated depreciation, nil/concessional excise and customs duties, and generation based incentives or feed-in-tariff, capacity building, awareness generation, institutional development etc. A series of activities including

Table 1: Plan-period-wise capacity addition in grid connected renewable energy based power generation installed capacity

Resource	Estimated Potential (MW)	Capacity Addition (in MW)				
		Upto 9th Plan	During 10th Plan	Targets for 11th Plan	During 11th Plan upto 31 March 2011	Total capacity as on 31 March 2011
Wind Power	48,500	1,667	5,427	9,000	7,063	14,157
Small Hydropower	15,000	1,438	538	1,400	1,067	3,043
Bio power*	23,700	390	795	1,780	1,488	2,673
Solar power	20-30 MW/sq km	2	1	50	35	38
Total		3,497	6,761	12,230	9,653	19,911

* Including biomass power, bagasse cogeneration, urban and industrial waste to energy.

Students visiting C-WET facilities, Chennai

award of Renewable Energy fellowships, incorporating renewable energy in the course curriculum and training programmes for renewable energy professionals for meeting the ever increasing human resource requirement in renewable energy area have also been taken up.

Progress of Renewable Energy

India has been making continuous progress in conventional as well as renewable power generation. From the year 2002 onwards, renewable grid capacity as a percentage of total capacity has increased by almost four times (Table 1). Due to continuous efforts of MNRE a number of decentralised renewable energy systems have been deployed and are in the daily use by the people all over the country (Table 2).

Off grid applications are major Indian renewable energy priorities. Such applications not only replace fossil fuels but also make significant contribution to reduction in their consumption. The strength and potential of renewable energy lies in its ability to generate power in a decentralised and distributed mode which has the advantages of production at consumption points and does away with land and environment related concerns and problems. Accordingly, the Ministry has put in place a policy framework for rapid upscaling of off grid programmes in an inclusive mode.

New Initiatives

Several new initiatives have been taken to make renewable energy affordable to the common masses and to meet their electricity and energy needs all over the country. Some of these initiatives are as follows:

- Jawaharlal Nehru National Solar Mission has been launched and operationalised, which aims at installation of 20000 MW solar power, 2000 MW off-grid solar applications, and 20 million sq m solar thermal collectors by 2022. About 804 MW grid connected projects and 32 MW off-grid projects have been sanctioned for implementation.
- Augmentation of tail-end power has been accorded high priority with renewable power plants of 1-2 MW where power is fed to 11 KV grid. This is expected to reduce the transmission losses by 5-7 per cent and improve both voltage and frequency at the tail end.
- Special project in Ladakh has been launched with a budget of Rs 473 crore to reduce diesel consumption through small/micro hydel and solar photovoltaic power projects/ systems, use of thermal systems for meeting water heating/ space heating/cooking requirements and set up green houses to increase vegetable production.
- A pilot project to demonstrate the potential of larger and

Table 2: Decentralised renewable energy systems deployed in India

Resources	Cumulative Achievements (in MW upto 31 March 2011
Off-grid / Distributed Renewable Power (including Captive / Cogeneration Plants	
Biomass power /cogen (non-bagasse)	301.61 MW
Biomass Gasifier	132 MWeq
Waste - to - Energy	70.42 Mweq
Solar PV Power Plants	5.80 MWp
Aero - generators / Hybrid Systems	1.12 MW
Total	**510.95 MWeq**
Decentralised Energy Systems	
Family Type Biogas plant	4,326 lakh
SPV Home lighting system	6,69,805
Solar lantern	8,17,549 nos.
SPV street lighting system	1,22,697 nos.
SPV Pumps	7,495 nos.
Solar Water heating - collector area	4.0 million sq m
Upgraded water mills/PICO hydra	1400 nos.

efficient biomass cookstoves for community application such as Anganwadi, Mid-day meals in schools, Dhabas, etc.

- 21 bagasse cogeneration projects have been taken up through build, own, operate, transfer (BOOT) model in cooperative sector sugar mills.
- 60 Solar cities and 50 new townships/campuses are being developed as green townships under Solar Cities Programme.
- Green buildings with Green Rating for Integrated Habitat Assessment (GRIHA) rating system are being promoted and so far 117 projects with about 5 million sq m built up area have been registered for acquiring GRIHA rating.
- The mechanism of renewable purchase obligations, leading over to facilitating renewable energy certificates (RECs) has been operationalised by Ministry of Power, which will boost the renewable power installations.

Renewable Energy and Private Sector

The growth of renewable energy in India has largely been led by the private sector. Ernst and Young ranked India the fourth most attractive country for renewable energy investment in the world, only behind the United States, China and Germany. As per an estimate, in 2009 the total financial investment in clean energy in India was at Rs 135 billion. Apart from this, Indian Renewable Energy Development Agency (IREDA) and other public sector agencies are also actively funding renewable energy projects.

The private sector has a large manufacturing base in the country. In fact the manufacturing of solar cells and modules, wind power machinery and equipments, biomass gasifiers, solar thermal collectors and concentrators, small hydro power turbines, is not only catering to the demand of the domestic market but is also exporting to many developed countries.

Conclusion

These strategies and policies of MNRE are expected to result in cost reduction, opening the market, developing business models, improving regulatory and policy initiatives, increasing private sector participation, enhancing monitoring and bringing in new technologies through in house R&D and import. More funds are required to offset the higher initial cost and proper propagation of renewable energy in the country. In fact renewable energy needs to be seen not as an alternative but a part of the energy solution in the country. Renewable energy needs to be adopted by all and it should not remain only a Government driven/ promoted sector. ✪

The author is Director, Ministry of New and Renewable Energy, New Delhi, email: aktripathi@nic.in

Ministry of New and Renewable Energy

"PRAKRITIK URJA PURASKAR YOJNA"

Ministry of New and Renewable Energy, Government of India, is operating 'Prakritik Urja Puraskar Yojna' to encourage original book writing in Hindi or translation of books in Hindi in the field of New and Renewable Sources of Energy. Under the scheme, there is a provision to award a first prize of Rs. 50,000/-, a second prize of Rs. 30,000/- and a third prize of Rs. 20,000/- every year. All authors, whether Government employees or Non-Governmental persons, can participate in the scheme. Entries are invited for the award for the calendar year 2010. The last date of receipt of entries is August 31st, 2011. Entries will be accepted in prescribed proforma only.

For further details, please contact
Dy. Director (OL),
Ministry of New and Renewable Energy
Block – 14, CGO Complex, Lodhi Road,
New Delhi – 110 003
Tel. +91 11 24362356
or visit this Ministry's
website www.mnre.gov.in

ROSHNI

An environmental initiative at the President's Estate

"*Roshni* is a concept which needs to be adopted and adapted. It will bring about a change in the attitude of people towards a more environmentally conscious lifestyle."
Smt. Pratibha Devisingh Patil, President of India

The President of India, Smt Pratibha Devisingh Patil on 19 May 2011 inaugurated a one day Seminar on the "Universalisation of Roshni" - an environmental initiative already in practice in the President's Estate. The Seminar has been organised by the President's Secretariat at Rashtrapati Bhawan to gain a better understanding of this green initiative, as well as to deliberate on how best to disseminate the idea beyond the confines of the President's Estate.

The Roshni initiative is an effort to help and equip the residents of the Estate to live in harmony with nature. The initiative, which was launched in 2008, comes against the background of issues concerned with climate change, with an effort to make the residents of the Estate more aware about the challenges faced and to be concerned about the degradation of the natural ecosystem.

In her inaugural address, the President said that the need to foster the spirit of Roshni is necessary, as the impact of environmental degradation is clearly apparent today, whether it is the rise in the global temperatures; haphazard weather patterns; depletion of the ozone layer; change in the sea levels or the growing spate of natural catastrophes. The President emphasised that "With urbanisation emerging as one of the

most significant drivers of global environment change, those of us living in concrete dominated city environments, cannot afford to remain apathetic or indifferent to the mounting degradation of our natural ecosystems".

Expressing satisfaction about the Roshni initiative, the President said, "From a humble start, today it encompasses a shelf of 13 activities. As Roshni spread its wings, we felt the need to institutionalise Roshni as a regular environmental management system. We have in place an Environment Policy for the Estate. All activities which impact environment have been put to audit, and our environmental practices have been subjected to external validation. We crossed the first milestone in 2010 when we received the ISO 14001 certification. Carbon emission reduction is also being monitored, and carbon footprint reduction potential is being analysed to show the way forward".

The Union Minister of New and Renewable Energy Dr Farooq Abdullah in his address said that Solar Energy has the potential to change lives. He highlighted his Ministry's Special Area Demonstration Project, introduced in July, 2009. Under this project, several Raj Bhavans have adopted measures for using renewable energy sources. The Minister also announced that the Green Campus Guidelines shall soon be announced by his Ministry. The Union Minister for Urban Development Shri Kamal Nath, in his remarks emphasised the fact that cities in the country will become engines of economic growth, due to which there is a need to reduce the environmental costs. There is an urgent need for sustainable urbanisation, sustainable sub-urbanisation as well as planned sub-urbanisation. The Minister announced that his Ministry shall adopt Roshni and integrate it with the Urban Development Ministry's Mission programme. The Chief Minister of Delhi Smt Sheila Dixit in her remarks highlighted the many measures taken by the Government of National Capital Territory of Delhi to popularise the green concept amongst the youth of the State. The Minister of State for Human Resource Development, Dr D Purandeswari was also present at the inaugural function. Shri Deepak Gupta, Secretary, Ministry of New and Renewable Energy emphasised on the need for ensuring green building constructions in the country. He urged the representatives of the educational institutions to develop their institutions as green campuses.

About 300 participants from the government departments, universities, IIT's, IIM's, central public sector units, private sector companies, industry associations as well as consultants took part in the Seminar. ❂

Promoting Renewable Energy:
Global Technology Cooperation, Innovation and Investment

> "I appreciate your effort in organising the Congress with a view to deliberate on challenges in exploring various alternate sources of energy and its use."
>
> - Sushil Kumar Shinde,
> Union Minister of Power, Government of India.

Second World Renewable Energy Technology Congress (WRETC) and Exhibition 2011 from 21 to 23 April at New Delhi, India.

HE Mr Jaime Nualart, Ambassador, Embassy of Mexico in India inaugurated the WRETC 2011 at Sovereign Hall, New Delhi on 21 April 2011. The congress was attended by 325 delegates, dignitaries and speakers from 33 countries representing various government departments, private-public sectors and academia. The exhibition of green technology, services, equipments and know-how of various renewable energy sectors was inaugurated by Professor Ali Sayigh, Chairman-WREC and Director General-WREN.

During the three days conference a theme session, plenary sessions, keynote sessions, twelve technical sessions and two panel discussion sessions were conducted to exchange ideas and discuss technology applications to improve efficiency and future technology development in the various segments of renewable energy viz. solar, wind energy, photovoltaic, hydropower, fuel cells and biofuel-biomass. The exhibition showcased various green technologies services and know-how of different renewable energy sectors. Students of graduate and post graduate colleges actively participated in the art/poster competition.

The five Energy and Environment Foundation Excellence Awards 2011 in renewable energy sector were conferred during the Valedictory Session on 23rd April 2011 by the Chief Guest Dr Bhishma Narain Singh, Former Union Cabinet Minister and Governor, Government of India to Dr Gustav R Grob, President-ICEC, Switzerland; Professor Ali Sayigh, Chairman-WREC and Director General-WREN, UK; Dr Osman Benchikh, Head, Renewable Energy Programme-UNESCO, France; Mr V Subramanian, Secretary General-IWEA, India; Padma Shri Mr Rakesh Bakshi, CMD-RRB Energy Limited, India.

Two memoranda of understanding were signed between Energy and Environment Foundation, New Delhi, India and Carleton Sustainable Energy Research Centre (CSERC), Carleton University, Ottawa, Canada and The School of Engineering Technology and Applied Science at Centennial College, Toronto, Canada for the promotion of renewable energy technology and green business in India and Canada. During the valedictory session a joint declaration was adopted and also signed by eminent personalities from USA, UK, France, Switzerland, Sweden, Germany, Iran, Italy, Canada and India on behalf of all participants. ✪

Cooking with BIOFUEL

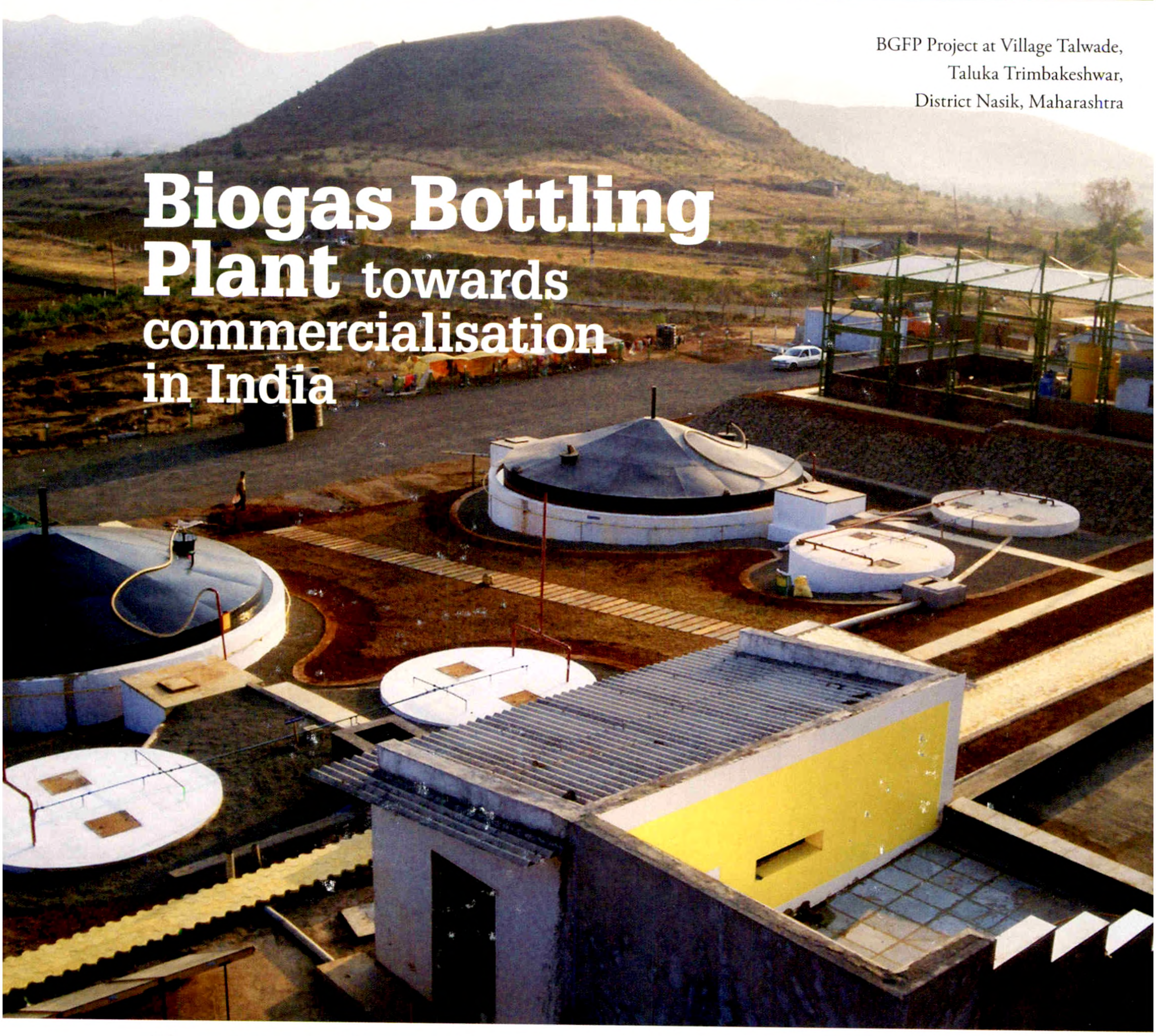
Investments in the renewable energy sector have soared with rapidly growing generating capacities as well as manufacturing capabilities.

Around 2900 prisoners are locked inside the Central Jail, Raipur. 18 LPG cylinders used to be consumed daily in order to cook for the inmates. A biogas plant of 35 cu m capacity was constructed by the Chhattisgarh Renewable Energy Development Agency (CREDA) with a view to use the dung of the 60 cattle in the dairy within the jail premises, in order to conserve energy and exploit the renewable energy resources. This plant will provide 300 KW thermal power capacity and the setting up of the two biomass gasifiers has spared the use of the 18 LPG cylinders daily. The burning of only 1100 kg fuel wood worth Rs 3,500 saves daily LPG usage worth Rs 7,000. Thus, around 6,570 LPG cylinders amounting to Rs 25 lakhs are saved annually.

A solar concentrator based steam cooking system is also being set up by CREDA in the Central Jail. With this system spread over 272 sq km concentrator area, dependence of this Jail on conventional fuels will come to an end. The project cost will be Rs 48 lakhs and the stake holding contribution of Rs 30 lakhs has already been paid by the Jail Administration. The project is likely to be completed within the calendar year of 2011.

Electricity is to be produced through night soil. After execution of this scheme, work on Project Night Soil for saving electricity will begin. This would be the scheme for the year 2012-2013. The government has sanctioned Rs 17.5 crores to the Jail Department for this purpose. A new tank would be constructed by connecting the jail toilets with that of old jails. Electricity would be generated through night soils filled in the tank for supplying to the jail and the residences.

Biogas Bottling Plant towards commercialisation in India



BGFP Project at Village Talwade,
Taluka Trimbakeshwar,
District Nasik, Maharashtra

The Ministry of New and Renewable Energy (MNRE) has taken a new initiative for bottling of biogas to demonstrate an integrated technology package in entrepreneurial mode on medium size mixed feed biogas-fertilizer plants (BGFP) for generation, purification/enrichment, bottling and piped distribution of biogas.

M L Bamboriya

Keeping in view the energy shortage in the country there is a need to tap biomass resources such as cattle dung, kitchen waste, agricultural waste etc. for generation of biogas through the involvement of entrepreneurs and industries to set up decentralised biogas based energy infrastructure in the country, at the potential sites where biomass available is in plenty.

Under technology demonstration of new RDD&D Policy of Ministry of New and Renewable Energy (MNRE), the Ministry took up a new initiative for bottling of biogas to demonstrate an integrated technology package in entrepreneurial mode on medium size mixed feed biogas-fertilizer plants (BGFP) for generation, purification/enrichment, bottling and piped distribution of biogas.

Installation of such plants aims at meeting stationary and motive power, cooling, refrigeration and electricity needs in addition to cooking and heating requirements. Under the demonstration phase, the Ministry is providing a central financial assistance of 30-50 per cent of the cost (excluding cost of land) for a limited number of such projects for implementation following an entrepreneurial mode on built, own and operate (BOO) and reimbursement basis.

So far 15 BGFP projects with aggregate capacity of 11,200 cu m per day have been sanctioned in 8 States, namely Gujarat, Karnataka, Punjab, Chhatisgarh, Haryana, Maharastra, Rajasthan and Bihar by the MNRE for implementation.

The first biogas bottling plant

A 500 N cu m biogas generation per day capacity BGFP project for generation, purification/enrichment, bottling of biogas was sanctioned by the MNRE with Rs 50 lakh CFA during the year 2009-10 to Ashoka Biogreen Pvt Ltd at village Talwade, District Nasik, Maharashtra. The first biogas bottling plant was commissioned on 16 March 2011 after obtaining licence for filling and storage of compressed biogas in CNG cylinders from Petroleum and Explosives Safety Organisation (PESO).

> **The first biogas bottling plant under technology demonstration of new RDD&D policy of MNRE was commissioned on 16 March 2011.**

(Figures mentioned are on per day basis)

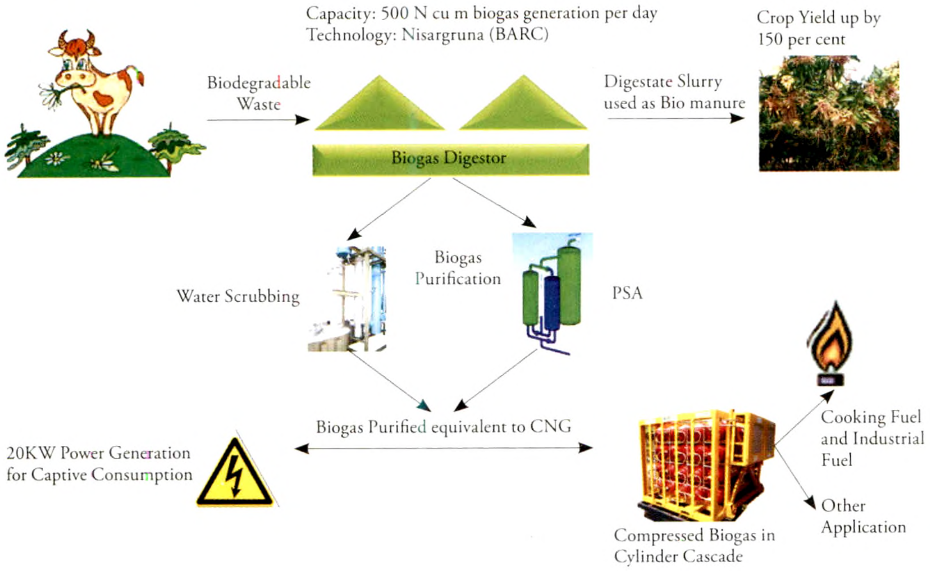
Items	Description
Quantity processed (Cow dung, agricultural waste etc.)	12.5 MT
Biogas generated	500 N cu m
Purified/upgraded biogas	270 N cu m
Purified biogas used for captive power generation (30 per cent)	81 N cu m
Power generated	160 units
Purified/upgraded biogas filled in cylinders at 150 bars*	16 cylinders of 9 kg each filled.
Slurry/manure**	20,000 lt/day

* Equivalent to Rs 5,040 of CNG or Rs 7, 200 of commercial LPG

** Used as liquid fertilizer substituting chemical fertilizer worth Rs 10,000.

The biogas generated from the plant has achieved a purity of 98.4 per cent methane and this has been corroborated through tests conducted by Shriram Institute for Industrial Research, Delhi (NABL). The purity of the enriched biogas is continuously monitored by an online analysing system along with calibration of analysers. The purified biogas is equivalent/similar to CNG. The schematic diagram of the BGFP project is given below.

Schematic Diagram of BGFP Project Installed at Ashoka Biogreen Private Limited, Village - Talwade, Taluka - Trimbakeshwar, District - Nasik (Maharashtra)


Capacity: 500 N cu m biogas generation per day
Technology: Nisargruna (BARC)
Crop Yield up by 150 per cent
Biodegradable Waste
Digestate Slurry used as Bio manure
Biogas Digestor
Biogas Purification
Water Scrubbing
PSA
Biogas Purified equivalent to CNG
20KW Power Generation for Captive Consumption
Cooking Fuel and Industrial Fuel
Other Application
Compressed Biogas in Cylinder Cascade

The biogas generation capacity of the plant is 500 N cu m per day and based on NISARGRUNA (BARC) Technology. The purity of biogas is about 98 per cent and it is compressed to 150-bar pressure for filling in cylinders.

The upgraded biogas is used for power generation, cooking and industrial application. The slurry of biogas plant is being used as an organic fertilizer in the nearby agro fields. The field trials have indicated 150 per cent growth in agro-production and substantial improvements in the quality. ❂

The author is Director, Ministry of New and Renewable Energy, New Delhi, mlbamboriya@nic.in

Glycerin CHP

Aquafuel has developed a new technology for the combustion of crude glycerin (glycerol) in standard diesel engined combined heat and power (CHP) generators. Developed in conjuction with leading biofuel supplier Greenergy, it further improves the sustainability of biodiesel production and is commercially available today.

Aquafuel's technology allows biodiesel producers to generate their own electrical power, and use the waste heat to provide process steam. Any excess electricity can be sold to the local grid, or used to run electric boilers for more process steam. The result brings biodiesel production close to energy self sufficiency and makes drastic cuts in fossil fuel usage.

Glycerin is a by-product of biodiesel production. For every 9 gallons of biodiesel, 1 gallon of crude glycerin is produced. Glycerin's density and high oxygen content offer the potential of exceptionally clean combustion, with much lower emissions than burning diesel fuel. Aquafuel's technology has turned that potential into practical reality.

The technology opens up the potential for any liquid fuel, from ethanol to gasoline, to be burnt at diesel efficiencies. The use of conventional, not bespoke, equipment means capital costs are comparable with conventional diesel CHP.

www.aquafuelresearch.com, July 2010

Antireflection advance in Solar Cells

Researchers in the United States, using the National Renewable Energy Laboratory's (NREL) one-step, metal-nanocatalyzed, liquid-etch technique to sculpt a nanoporous surface - known as "black silicon" - made the first silicon solar cell to reach an efficiency >14 per cent without using a vacuum deposited antireflection coating. The cell is made via processes that are otherwise virtually identical to industrial wafer cell practice, and it has a confirmed efficiency of 16.8 per cent with less than 3 per cent reflection across the solar spectrum. The etch was achieved in 3 minutes, but the NREL team obtained similar black silicon with a 30-second etch at 40°C.

The team earned a 2010 R&D 100 Award for this technology. The cell can be improved to reach efficiencies greater than 19 per cent by reducing reflection and improving the conversion efficiency for blue light in the solar spectrum. Adoption of this new form of antireflection would replace vacuum deposited silicon nitride with the less expensive liquid etch. Analysis by NREL indicates that the black silicon process decreases the cost per watt of a silicon module by an amount equal to the effect of a 0.5 per cent increase in cell efficiency. An additional improvement in annual energy production (at the same cell power rating) results from black silicon's excellent angular acceptance properties compared to conventional antireflection coatings. Several commercial partners are negotiating with NREL for cooperative research and/or licensing of the technology.

NREL Principal Scientist Howard Branz examines silicon wafers with various antireflective treatments. The black silicon cell is on top.

www.nrel.gov, May 2011.

Nanomaterials for more efficient solar cells

A new European Union (EU) funded project is turning to nanotechnology in a bid to dramatically ramp up the efficiency of solar cells. Called ROD-SOL ('All-inorganic nano-rod based thin-film solar cells on glass'), the three year project has a budget of EUR 4 million, EUR 2.9 million of which will come from the 'Nanosciences, nanotechnologies, materials and new production technologies' (NMP) Theme of the Seventh Framework Programme (FP7).

The aim of the project is to develop new, more cost effective nanomaterials for solar cells. In a time of rising energy prices, the race is on to develop new, cheaper ways of exploiting renewable energy sources. 'Photovoltaics is an important pillar of this effort, as solar energy is available in almost unlimited amounts,' commented project coordinator Dr Silke Christensen of the Institute of Photonic Technology (IPHT) in Germany.

The solar cells currently in use have an efficiency of around 18 per cent. However, producing these cells requires a lot of raw materials and is an extremely energy intensive process. In the future, thin film solar cells are expected to dominate the market, as their production costs are much lower. But the efficiency of these new cells, at around 10 per cent, is rather low.

The ROD-SOL project aims to up the efficiency of these thin film solar cells by developing and optimising the synthesis of silicon nanorods on cheaper substrates such as glass or metal foils. The silicon nanorods are effectively tiny silicon columns whose diameter is measured in nanometres (one nanometre being a billionth of a metre).

According to the project partners, these minute structures are ideal for trapping light energy so that it can be transformed into electricity. A major challenge for the researchers will be determining the optimal diameter of these nanorods, as the diameter influences the efficiency of the structures. The novel materials and processes developed in the project will be tested and implemented by the companies involved in ROD-SOL.

In total, the project counts seven research organisation partners, based in Austria, Finland, Germany, Hungary, Switzerland and the USA, and four industrial partners from Germany, Slovenia and Finland.

www.rodsol.eu, January 2011

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H-CNG Fuelling station set up at Dwarka, New Delhi

Hydrogen Energy and Fuel Cells Development in India

The Ministry of New and Renewable Energy (MNRE) has been supporting a broad based research, development and demonstration (RD&D) programme on different aspects of hydrogen energy technologies including hydrogen production, its storage and utilisation for stationary, motive and portable power generation using internal combustion engines and fuel cell technologies.

M R Nouni

Hydrogen is a clean energy carrier with the potential to replace liquid and gaseous fossil fuels in the coming decades. In recent years notable progress has been made globally in the development and demonstration of hydrogen energy and fuel cell technologies.

Hydrogen Production Technologies

Hydrogen can store and deliver usable energy, but it does not exist by itself in nature. It must be produced from compounds that contain it. Hydrogen can be produced using locally available resources including natural gas, coal and nuclear; biomass and other renewables including solar, wind, hydro-electric, or geothermal energy. This diversity of using locally available energy sources makes hydrogen a promising energy carrier and it is considered important from the energy security view point. The development of clean, sustainable, and cost-competitive hydrogen production processes is considered key to a viable future hydrogen economy and research and development efforts are being made in this regard.

> **The development of clean, sustainable, and cost-competitive hydrogen production processes is considered key to a viable future hydrogen economy and research and development efforts are being made in this regard.**

Hydrogen production technologies fall into three general categories: thermal processes, electrolytic processes, and photolytic processes. Some thermal processes use the energy of resources such as natural gas, coal, or biomass to release hydrogen, which is part of the molecular structure of the resource. In other processes, heat, in combination with closed-chemical cycles, produces hydrogen from feedstocks such as water. These are known as 'thermo-chemical' processes. However, thermo-chemical process is a long-term technology, which is still in the early stages of development the world over. Steam methane reformation process is most widely used for production of hydrogen for industrial applications. Distributed natural gas reforming is an important pathway for near-term hydrogen production option. Reduction in capital equipment costs, as well as operation and maintenance costs and improvement in process energy efficiency are key challenges for producing hydrogen at a competitive cost vis-à-vis fossil fuels. The gasification of coal is another method that can be used to produce hydrogen in addition to its existing uses like production of power, liquid fuels and chemicals. Hydrogen can also be produced by gasification of biomass.

Electrolytic processes use electricity to split water into hydrogen and oxygen. Hydrogen produced via electrolysis can result in zero greenhouse gas emissions, depending on the source of the electricity used. Globally efforts are underway for development and improvement in polymer electrolyte membrane electrolysers, alkaline electrolysers and solid oxide electrolysers.

Photolytic processes use light energy to split water into hydrogen and oxygen. Currently these processes are in the very early stages of research. However, these processes offer long-term potential for sustainable hydrogen production with low environmental impact.

The Ministry of New and Renewable Energy (MNRE) has been supporting a broad based research, development and demonstration (RD&D) programme on different aspects of hydrogen energy technologies including hydrogen production, its storage and utilisation for stationary, motive

H-CNG fuelled vehicles

> **Fuel cells are an important technology for utilisation of energy in a cleaner and more-efficient manner to the combustion of liquid and gaseous fossil fuels.**

and portable power generation using internal combustion engines and fuel cell technologies. The focus of the programme of the Ministry is on development of processes for hydrogen production through renewable energy methods. In the context of hydrogen production, decomposition of water through thermo-chemical, photo-electro-chemical and photo-catalytic methods using solar energy and through the microbial and gasification routes of biomass are being pursued in the country. Proton exchange membrane (PEM) electrolyser for hydrogen production using water and water-methanol solution have been developed. RD&D projects for hydrogen production by reformation of biomass derived glycerol (Fig 1); decomposition of hydrogen sulphide using solar energy and non-thermal plasma; and decomposition of renewable and fossil fuel based liquid and gaseous hydrocarbons by non-thermal plasma reformation technique are also under implementation. RD&D projects for production of hydrogen through electrolysis of water using electricity generated by small wind electric generator(s); and decomposition of water using photo-electro-chemical route have been supported recently.

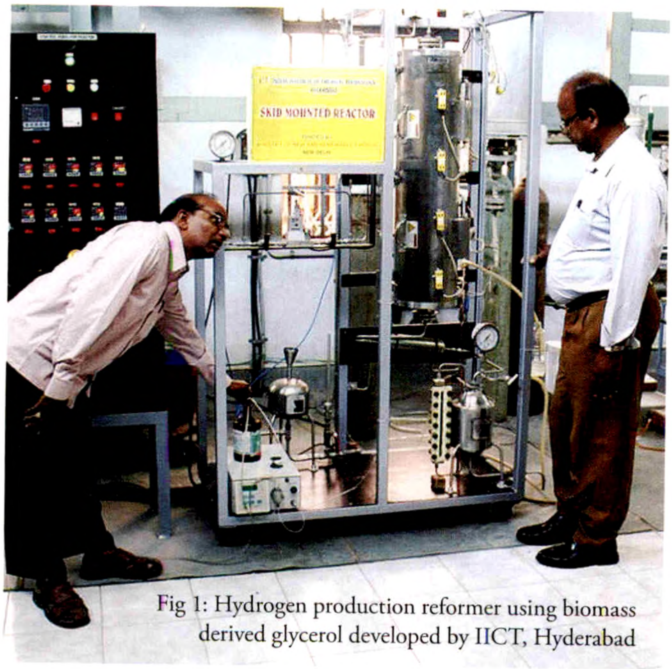


Fig 1: Hydrogen production reformer using biomass derived glycerol developed by IICT, Hyderabad

Hydrogen Storage

On-board hydrogen storage for transportation applications continues to be one of the most technically challenging barriers to the widespread commercialisation of hydrogen-fuelled vehicles. International efforts are focused on the applied research and development of technologies to allow for a driving range of more than 500 km. In addition, hydrogen storage efforts are also devoted towards off-board uses such as for stationary power generation and for hydrogen delivery and refuelling infrastructure.

Storage of hydrogen in solid-state materials is considered to be safe in comparison to high pressure gaseous and liquid hydrogen storage and is, therefore, one of the focus areas of research in the country. The Ministry is presently supporting research and development projects on hydrogen storage through development of metal hydrides and complex hydrides such as sodium alanates, magnesium alanates, lithium and magnesium amides, liquid organic hydrides and carbon materials.

Applications of Hydrogen Energy

Apart from its existing uses in industry as a chemical/feedstock, hydrogen can be used as a clean fuel in automobiles and also for power generation through internal combustion engines and fuel cells. Many automobile companies are engaged in development and demonstration of internal combustion engine based vehicles.

With a view to supply hydrogen blended compressed natural gas as an automotive fuel, a hydrogen-compressed natural gas (H-CNG) dispensing station has been set up at Dwarka in New Delhi with partial financial support from the Ministry during 2008-09. A development cum demonstration project for use of H-CNG as fuel in select vehicles (3 buses, 2 cars and 2 three wheelers) is also under implementation. Initial testing carried out under the project have indicated that blending of hydrogen with CNG can reduce emissions from the vehicles. Based on the tests conducted for performance and emissions with different blends of hydrogen with CNG, an optimised blend ratio of 18 per cent hydrogen by volume with CNG has been finalised as the fuel to be used in test vehicles.

Fuel Cells

A fuel cell is an electrochemical device that converts chemical energy of hydrogen directly into electricity and heat without combustion. Fuel cell systems generally operate on pure hydrogen and air/oxygen to produce electricity with water and heat as the by-products. Fuel cells are an important technology for utilisation of energy in cleaner and more-efficient manner to the

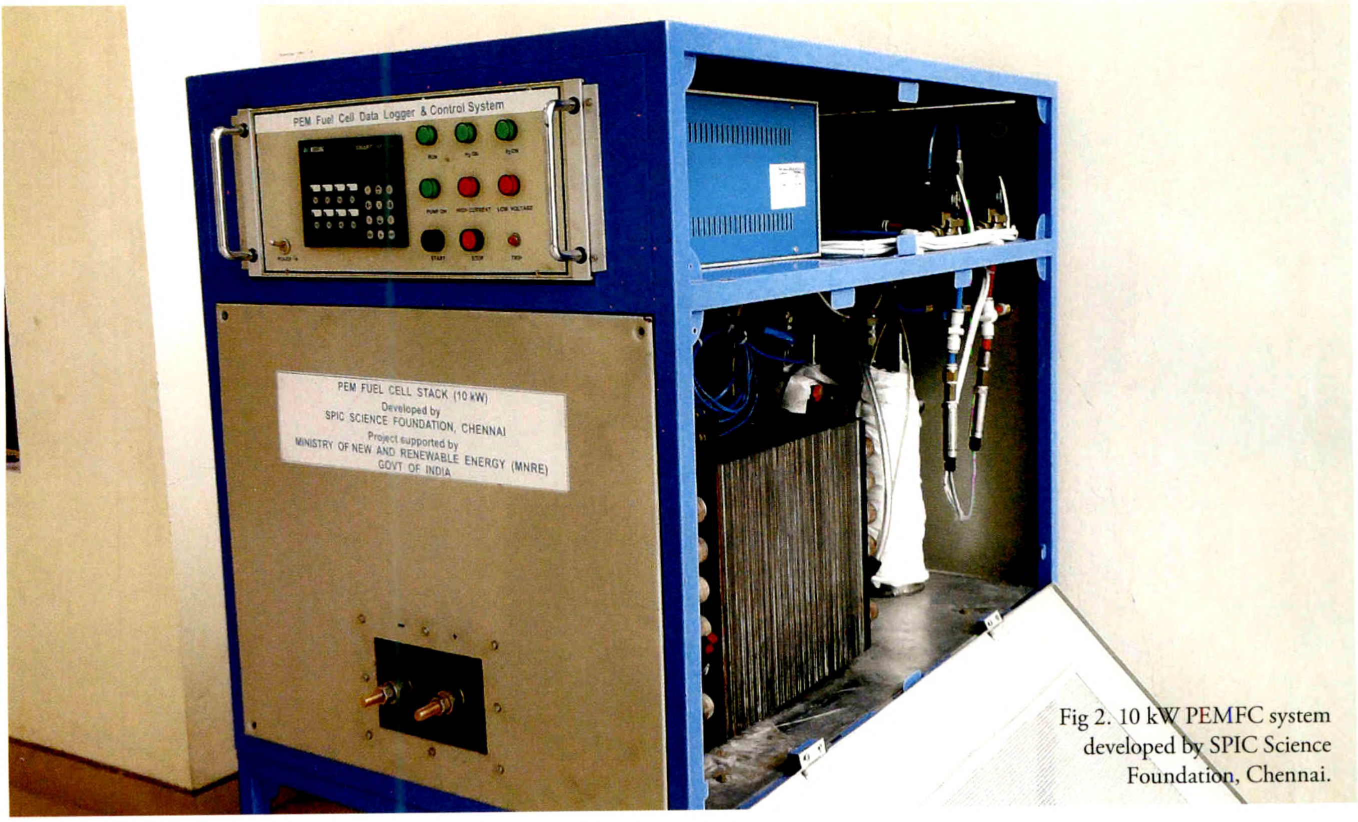

PEM Fuel Cell Data Logger & Control System
PEM FUEL CELL STACK (10 kW)
Developed by
SPIC SCIENCE FOUNDATION, CHENNAI
Project supported by
MINISTRY OF NEW AND RENEWABLE ENERGY (MNRE)
GOVT OF INDIA

Fig 2. 10 kW PEMFC system developed by SPIC Science Foundation, Chennai.

combustion of liquid and gaseous fossil fuels. Fuel cells have the potential to replace the internal-combustion engine in vehicles and provide power in stationary and portable power applications because they are energy-efficient, clean, and fuel-flexible. Fuel cell power systems can be used as uninterrupted power supply (UPS) systems, replacing batteries and diesel generators.

In view of the relevance of fuel cells for power generation and transport applications, several organisations globally are pursuing RD&D activities for development of Polymer Electrolyte Membrane Fuel Cells (PEMFC) for automotive and stationary power generation applications. A number of automobile companies have developed and demonstrated PEMFC based cars and buses. Among different types of fuel cells, while Direct Methanol Fuel Cells (DMFC) Direct Ethanol Fuel Cells (DEFC) are being developed for portable applications, high temperature fuel cells like Molten Carbonate Fuel Cells (MCFC) and Solid Oxide Fuel Cells (SOFC) are being developed for stationary applications. Phosphoric Acid Fuel Cells (PAFC) have been developed and commercialised. The present efforts in these fuel cells are focused on reducing its cost and improving its durability.

The focus of the Fuel Cell programme of the Ministry has been on supporting RD&D activities on different types of fuel cells namely PEMFC, DMFC, DEFC, MCFC, SOFC and PAFC. The emphasis of research has been on further improvements in fuel cell related processes, materials, components, sub-systems and fuel cell systems. Research and development efforts for indigenous development of membranes and catalysts for DMFC are currently underway. PEMFC is considered as the preferred technology for automotive applications and, therefore, research efforts have been supported for development of components like polymer electrolyte membrane, electro-catalysts, bipolar plates and stacks suitable for automotive applications (Fig. 2).

Mission Mode Projects

The National Hydrogen Energy Road Map (NHERM) for the country prepared in January 2006 and keeping in view the broad directions provided in the NHERM, the Ministry has supported four Mission Mode Projects in the areas of hydrogen production through biological route, hydrogen storage in hydrides and carbon materials and development and demonstration of hydrogen fuelled internal combustion engines for vehicles. Two Technology Mission Mode Project proposals relating to development of PEMFC and SOFC in collaboration with the industry are under development and evaluation. ✪

The author is Director, Ministry of New and Renewable Energy, mrnouni@nic.in

Hybrid Energy Systems In Telecommunication Industries

This paper presents the concept of a solar-wind hybrid energy system for GSM type mobile telephony tower applications and explores the possibility of putting hybrid energy systems for powering cellular mobile base station sites application.

Dr Pragya Nema

> **The use of the stand-alone solar-wind systems with a diesel backup for power supply in remote areas may give an economically attractive alternative to the mobile telecom sector over the use of conventional diesel generators.**

Obtaining reliable and cost effective power solutions for the worldwide expansion of telecommunications into rural and remote areas presents a very challenging problem. Grids are either not available or their extensions can be extremely costly in remote areas. A sustainable alternative to power remote base station sites is to use renewable energy sources. Recent research and development of renewable energy sources has shown their excellent potential as a form of contribution to conventional power generation systems. In order to meet sustained load demands of mobile base stations during varying natural conditions, different energy sources and converters need to be integrated with each other for extended usage of alternative energy. For Indian remote locations, one of the alternative solutions of renewable energy sources is a wind-solar hybrid energy system. The use of the stand-alone solar-wind systems with a diesel backup for power supply in remote areas may give an economically attractive alternative to the mobile telecom sector over the use of conventional diesel generators in the near future. This paper gives a design idea of a wind-solar photovoltaic (PV) hybrid energy system.

Based on the energy consumption of the mobile base station and the availability of renewable energy sources, it was decided to design an innovative stand-alone hybrid energy system combining a small wind turbine-generator, solar PV panels, battery storage, advance power electronic equipment and existing diesel generators. The system architecture employed in the hybrid system is AC-coupled where the renewable energy sources and the conventional diesel generators all feed into the AC side of the network as shown in Fig 1.

METHODOLOGY USED FOR HYBRID SYSTEM

The first step in developing the hybrid energy system consists of a system simulation procedure in order to examine whether a system configuration, comprising a certain number of system components and installation details, fulfils the power supply requirements during the year. The data used in this case are the daily solar irradiation on a horizontal plane, the hourly mean values of ambient temperature, wind speed and the base transceiver station (BTS) power requirements over a one year time period.

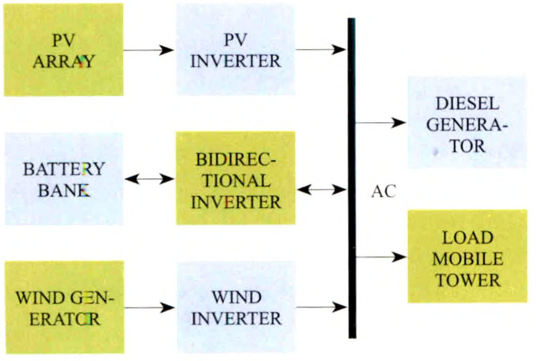


Fig 1. Proposed hybrid system architecture for mobile base station

The second step of optimal sizing procedure consists of gathering solar irradiation and wind speed data from the weather station situated at the BTS site or the local meteorological station. The different optimal feasible combinations of hybrid system components for a particular BTS site were obtained and stored. Then the best optimal combination of system components at a minimum cost could be chosen.

RENEWABLE ENERGY RESOURCES

The availability of renewable energy resources at mobile base station sites is an important factor to develop the hybrid system. In many parts of India both wind and solar energy is abundantly available naturally. Therefore the first choice to power the mobile base station will be renewable energy sources such as wind and solar. Weather data are an important factor for pre-feasibility study of renewable hybrid energy system for any particular site.

Solar energy resource For designing the hybrid energy system the hourly solar irradiation data for the year was collected for the specific site. In summer, solar power is higher than winter season. In rainy season clearness index and solar power, availability is lower than summer and winter season.

Wind energy resource As with solar power, wind power can provide virtually free energy. However, the wind power industry is moving towards very large wind turbines, and the challenge is to find a cost-effective solution for a radio base station (RBS) site. The big advantage of wind power is that a turbine can support a traditional macro RBS site without too large an impact on cost. On the downside, there is the erratic nature of wind, which means that a small

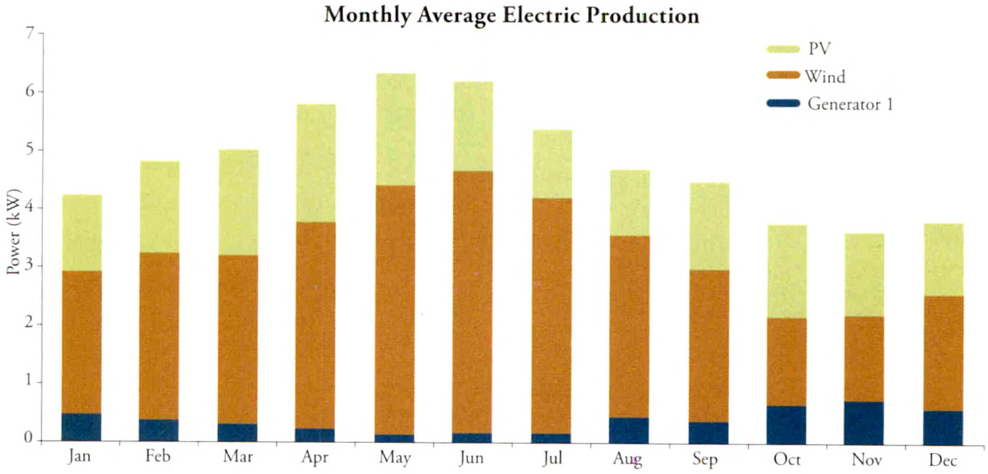


Fig 2. Annual electricity production by different hybrid system components

> **The Base stations powered by the solar-wind hybrid energy systems are proving to be an environment friendly and cost-effective solution for many challenging sites.**

diesel generator or some other power source is needed to fill-in power during periods of low, or no, wind. Currently, wind power also demands extra site space, because of the need for an extra mast or tower to house the wind turbine.

LOAD PATTERN FOR MOBILE TELEPHONY BASE STATION

Cellular telephone service is a rapidly expanding and very competitive business world over. There are about 55,000 different types of base stations for the telecom sector in India and most of them run on diesel generators, which are expensive to run. Different types of telecom base stations are used according to the technological advancement in telecommunication sector. Now the GSM 2/2/2 (2nd Generation Global System Mobile) telephony base stations are also being used. The telecom companies operating in India consider the energy load requirement to be constant for the entire year and throughout the day of operation. For the pre-feasibility study of designing the solar-wind hybrid system a 2nd Generation GSM base station is considered. The data collected gave the actual load demand of a particular base station site, which was then simulated for the entire year. The assumption of telecom companies was found to be fairly accurate, as there was very low variation in the energy load requirement of a BTS across the day.

ANNUAL ENERGY GENERATED BY DIFFERENT SOURCES

The simulation result eliminates all infeasible combinations and ranks the feasible systems according to increasing net present cost. It also allows a number of parameters to be displayed against the sensitivity variables for identifying an optimal system type. The monthly average electricity production of a hybrid energy system for mobile telephony base station is shown in Fig 2. In this system the total production of electrical energy is fulfilling the load demand by a combination of 13 per cent PV, 56 per cent wind and the rest of the 31 per cent by diesel generators.

CONCLUSION

Alternate power solutions are not commonly used in mobile telecommunication systems today, but are being actively evaluated for use in the near future for remote and isolated areas all over the world. With the help of the above study it has been established that the solar-wind hybrid energy systems are a viable power solution for mobile base stations in remote Indian sites over conventional diesel generators. Although the net present cost is high but the running and maintenance costs are low as compared to the diesel generator.

The fuel consumption is also reduced to approximately 80 per cent and payback times on the investment in hybrid solar-wind powered base station sites are continuously decreasing. The base stations powered by the solar-wind hybrid energy systems with a diesel backup – are proving to be an environment friendly and cost-effective solution for many challenging sites. Operation and maintenance costs are extremely low, making it economical to extend cellular coverage in far-flung regions. ✪

The author is Professor, Electrical Engineering Department, Netaji Subhash Engineering College, Kolkata, rk_nema@yahoo.com

Towards Roof Top Solar

Setting up a PV Plant in Chandigarh

To fulfill its renewable purchase obligation, one option for the Chandigarh Electricity Department is to develop its own solar power facility. This study examines the feasibility of setting up a 1 MW roof top solar power facility in Chandigarh.

Sulata Bhandari and Ashish Kundu

The Electricity Act 2003 mandates the State Commissions to specify a percentage of the total consumption of electricity in the area of a distribution licensee, for purchase of electricity from renewable sources - renewable purchase obligation (RPO). The Joint Electricity Regulatory Commission (JERC) in its draft regulations for the development of power generation from renewable energy sources and for procurement of energy from renewable sources by distribution licensee has defined minimum quantum of purchase (in per cent) from renewable energy sources (in kWh) as shown in table 1:

Table 1: Minimum quantum of purchase from renewable energy sources as per JERC

Year	Minimum quantum of purchase from renewable energy sources (in kWh)		
	Total	Solar	Non Solar
2010-11	1 per cent	0.25 per cent	0.75 per cent
2011-12	2 per cent	0.3 per cent	1.7 per cent
2012-13	3 per cent	0.4 per cent	2.6 per cent

In this context, the Chandigarh Electricity Department may have to consider procurement of power from renewable sources for its electricity requirement to fulfill this obligation. One option for the Department may be to develop its own solar power facility. This study examines solar energy options for electricity generation that are appropriate for installation on roof top government/semi government buildings in Chandigarh.

Solar PV technology

Solar photovoltaic (PV) technology collects and converts solar radiation directly into electricity. PV generation technology is commercially proven and large multi-megawatt generation plants have been operating since the 1990s. Costs associated with the technology are high, but the technology is well-known and reliable.

PV panels convert sunlight to electrical energy. They generate direct current (DC) that is converted to alternating current (AC) to be used by the electricity grid. Regardless of the PV configuration, inverter hardware is required to change the direct current PV output to useable AC power for the grid.

Solar thermal technology

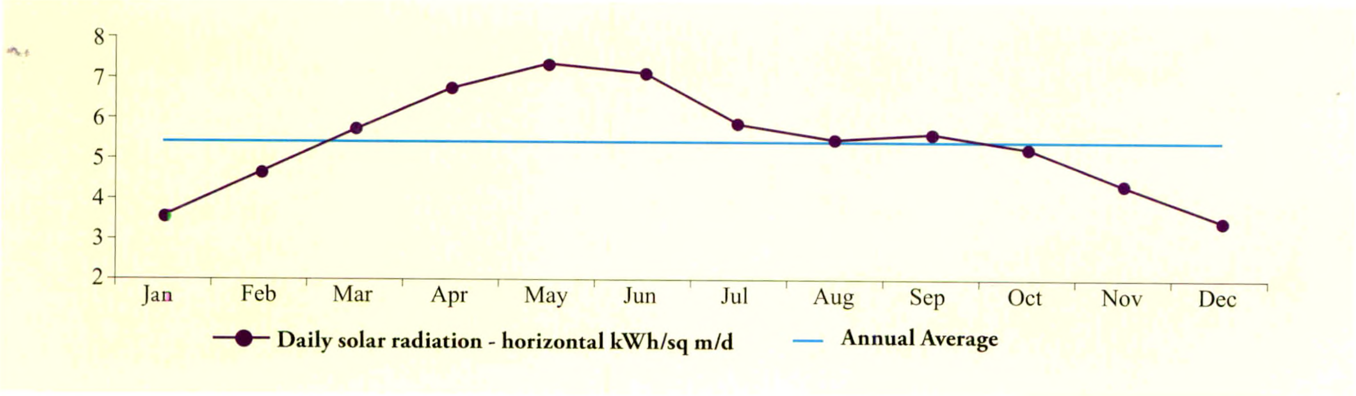
Solar thermal generation systems collect solar energy as heat to raise steam for use in a conventional thermal electricity generating plant (steam turbine). Solar thermal energy systems use the sun to supply heat and in higher temperature systems produce sufficient energy to drive machines for power generation. There are a number of solar thermal technologies that are considered for power generation such as Lower temperature solar thermal systems and Concentrating solar thermal (CST) power systems.

Solar panels on a roof top

Key study assumptions

- This study considers technology issues and high level costs. The guidelines issued by Ministry of New and Renewable Energy (MNRE) have been considered for availing financial assistance.

Fig 1: Monthly solar radiation in Chandigarh



- The daily solar radiations have been considered as per NASA report taken from the NASA web portal (Fig 1). While global solar radiation data is readily available and reliable for all locations, this is not true for direct radiation. The success of a solar thermal project depends heavily on the quantity and quality of the resource data. It is therefore prudent that site specific monitoring be carried out at one or more potential sites.
- The regulations notified by Central Electricity Regulatory Commission (CERC) for the procurement of power from Solar Plant by the distribution licensee have been considered for assessment of revenue from sale of power and some of the assumptions for estimating the cost of generation have been adopted from the same.

Possibility of roof top SPV in Chandigarh

Land availability: The approximate land requirement for 1 MW of solar PV plant is 2 hectares (20,000 sq m). Considering the availability of roof top areas of all the government/semi government buildings in Chandigarh, about 28 buildings of about 700 sq m clear roof top area each (70 per cent of roof top area of the building is considered usable for installation of PV panels) are envisaged for a 1 MW solar PV plant.

Size of the solar plant: With the available roof tops of the government/semi government buildings, 1 MW solar PV is achievable.

Hours of generation: The Solar plant is expected to achieve a plant load factor (PLF) of 19 per cent with expected annual energy outflow of 1.664 million units.

Capital cost - Rs 17 crores/MW: The above cost is as per the regulations of CERC, therefore, the capital cost for putting up 1 MW PV solar plant is considered.

Table 2: Assumptions considered for the calculation of estimated cost of generation as well as levelised cost spread over a period of 25 years

Particulars	Rate
Capacity Utilisation Factor	19 per cent
Operation and Maintenance charges	0.5 per cent of the capital cost
Depreciation	7 per cent for first 10 years, thereafter 1.33 per cent
Interest charges on loans	14.29 per cent
Loan repayment period	10 years
Return on equity	19 per cent for 10 years and 24 per cent 11th year onwards
DE ratio	70:30
Life time	25 years
Discount rate	16.60 per cent
Operation and maintenance expenses	Rs 9 lakhs with 5.72 per cent escalation per annum.
Interest on working capital	13.79 per cent

Based on these assumptions, the estimated costs are worked out as:

First Year Cost	Rs. 23.78/kWh
Levelised Cost	Rs. 18.44/kWh

The above costs may vary on either side in case of any variations in the above assumptions

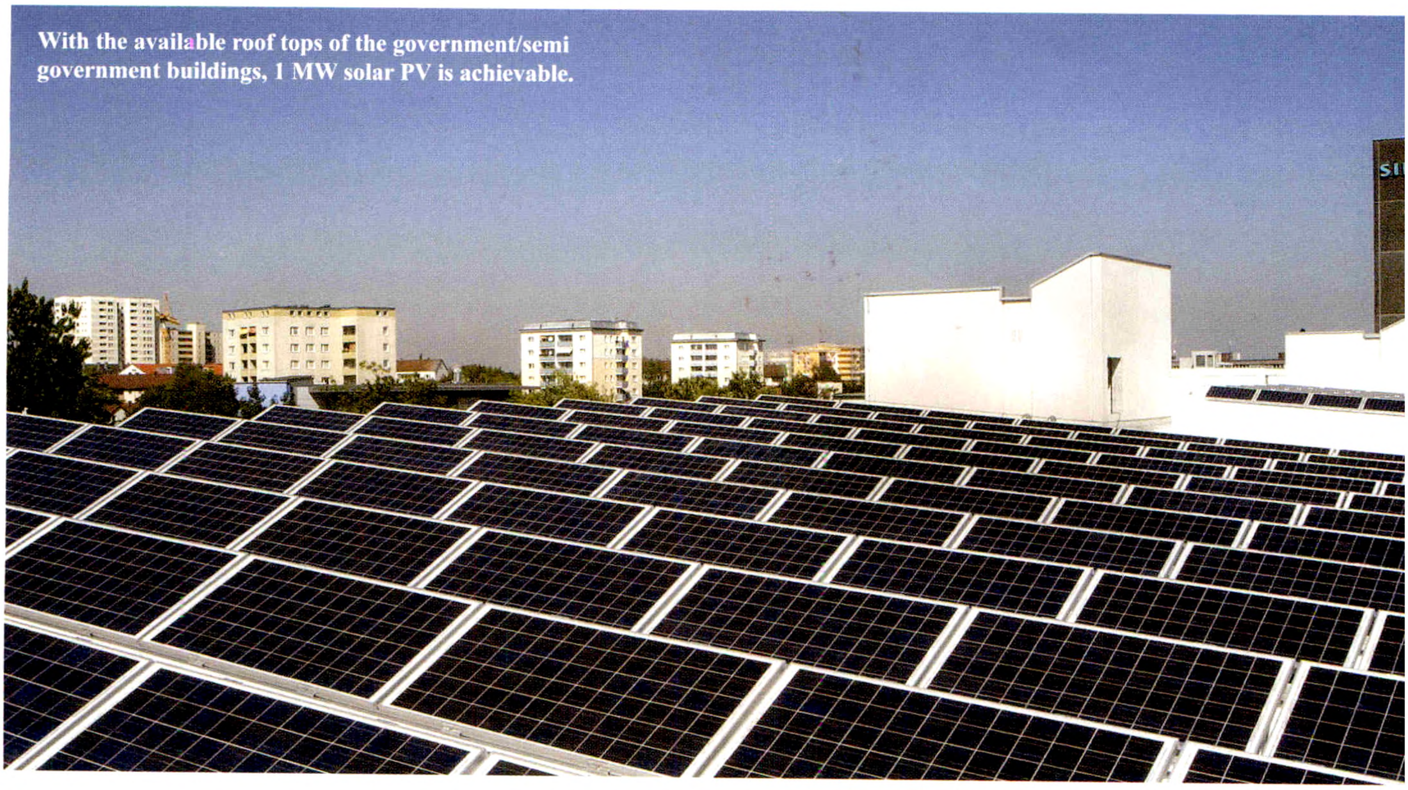
Estimated cost of generation: The assumptions that have been considered for the purpose of calculation of estimated cost of generation as well as levelised cost spread over a period of 25 years are given in table 2. These assumptions have been adopted from the solar power regulations notified by CERC.

Electrical connection to the network: Chandigarh Electricity Department operates the distribution network in entire Chandigarh city. The system shall be connected to the nearest 33/11 kV distribution network available with the local utility.

Before finalisation of the connection arrangements, it will be necessary to negotiate a network connection and access agreement and undertake further activities, such as:

- Stability studies;
- Investigation of connection issues including assessment of the need to upgrade or modify the Department's equipment due to an increase in fault levels;
- Protection modifications; and
- Regulatory Commission's approvals.

Services and infrastructure: This project will require the normal services and infrastructure expected for any small power generation plant. For a PV solar plant there is apparently less or no requirement of water and access to road should be available. For the proposed roof top solar PV plant, both road access as well as water is available.



With the available roof tops of the government/semi government buildings, 1 MW solar PV is achievable.

> **With installation of 1 MW solar PV on government/ semi government buildings in Chandigarh, the Electricity Department would be partly meeting its RPO as per JERC draft regulations.**

Environment: There are a range of drivers for renewable energy, over and above green house gas (GHG) reductions, in particular the environmental impacts of conventional power generation plants. For the proposed solar plant these environmental impacts are unlikely to be major constraints for the chosen site.

Electricity sales and revenue: For the purpose of this study, it is assumed that electricity produced by the solar PV plant on the buildings shall be consumed by the Electricity Department, Chandigarh, which will constitute 0.12 per cent of the total annual energy consumption (procurement) of about 1680 million units, which is just half of the Electricity Department's RPO. With a 1 MW solar roof top PV plant, there will be an incremental increase in the power purchase cost for the Department and also in the average retail tariff by about 1½ - 2 paise per unit. For the Department to fulfill its RPO of 0.25 per cent from solar energy, it has to put up nearly 2 MW of solar PV plants, which may necessitate putting up such plants in open area apart from roof tops. In such a scenario, the incremental increase in the power purchase cost and the average retail tariff is likely to be 2½ - 3 paise per unit.

Carbon credits: The project shall also qualify for earning carbon credits under Clean Development Mechanism.

Conclusions

- The annual average daily solar radiation at the proposed site is 5.44 kWh/sq m/d which is suitable for the proposed solar plant.
- With installation of 1 MW solar PV on government/ semi government buildings in Chandigarh, the Electricity Department would be partly meeting its RPO as per JERC draft regulations.
- Solar PV represents a true zero carbon emission generation option and for the proposed 1 MW Solar power plant, the Solar PV technology may be a better choice.
- The available land, roof top area in this case in Chandigarh is suitable for this project.
- The connectivity of proposed solar plant to the nearest 11 kV grid or LT grid is easy and favourable. ✪

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Biofuel Production

The need for a rethink

Dr Hooman Peimani

Biofuels can only be a suitable replacement for liquid fossil energy if their production process becomes completely environment friendly. India has the potential to produce large volumes of environment friendly biofuels, it also has the right type of carbon-neutral crop for such cultivation, Jatropha.

Concerns about the worsening climatic changes caused by global warming have motivated efforts to find replacements for fossil energy (oil, gas and coal), the main cause of carbon dioxide production accounting for the bulk of greenhouse gas emissions (about 75 per cent). In particular, finding environment friendly alternatives to liquid fossil fuels used for transportation (gasoline and diesel) have given birth to the production of biofuels globally. Today, biofuels consisting of a variety of liquid fuels (e.g., bioalcohols and biodiesels) produced mainly from agricultural products (e.g., corn, soya, sugar beats and sugar canes) account for 2 per cent of the global transport fuel equal to 55 million tons of oil equivalent. Such alternatives to liquid fossil fuels have the promise of helping reduce carbon dioxide emissions, as the various types of biofuels are either carbon dioxide free or produce a small amount of such pollutants as compared to their equivalents in liquid fossil energy.

However, the current type of biofuel production has resulted in deforestation, high emission of carbon dioxide, soil exhaustion, depletion of water resources, destruction and/or extinction of wild life, food shortages and higher prices for food.

The new practices: potential for a better result

Biofuels can only be a suitable replacement for liquid fossil energy if their production process becomes completely environment friendly. The so-called second, third and fourth generations of biofuels aimed at using non-edible crops and or biomass are still to be proven to be environment friendly and they are not yet commercially available at a large scale. A totally different type of biofuel production needs to be adopted.

Firstly, the land used for such production cannot be a destroyed forest, pasture or food-producing farm. Rather, it must be a dry, non-green and non-agricultural piece of land. In this case, selecting and preparing a land for biofuel production will not generate carbon dioxide. Nor will it deny earth its natural lung, the green life.

Secondly, the land used for biofuels production must be very close to its targeted market. This factor will decrease to the very minimum the distance for transporting the produced biofuel to its market to reduce energy consumption for its transportation and thus carbon dioxide emissions.

Thirdly, the water used for cultivating any given type of crop cannot be that of the existing water resources, but the recycled one. This factor will ensure the survival and the sustainability of the adjacent environment and its respective forms of life through the preservation of its required water resources. As such, it will help address the local water waste management, an energy-intensive undertaking.

Finally, non-chemical fertilizers and pesticides must be utilised. Thus, instead of chemical fertilizers which can have negative effects on the environment, organic fertilizers must be used. The cheapest available one is compost, which is very rich in minerals and vitamins necessary for cultivating crops for producing biofuels. Related to this, natural environment friendly solutions should be applied to deal with pests such as using their natural enemies (e.g. worms or insects) which are harmless for the growing crops. Therefore, chemical pesticides with a negative impact on the environment should not be used at all. In short, producing biofuels in this manner provides environment friendly alternatives to liquid fossil fuels, which can help reduce carbon dioxide emissions.

> **The second, third and fourth generations of biofuels aimed at using non-edible crops and or biomass are still to be proven to be environment friendly and they are not yet commercially available at a large scale.**

Implications for India

India has a growing demand for energy because of its large and expanding economy and increasing population. Its huge demand for liquid fossil energy is also growing owing mainly to the improving living standards of its population which has resulted in more vehicles on the road, in particular. At the same time, India is facing growing carbon dioxide emissions because of its increasing consumption of fossil energy. Given this situation, producing environment friendly biofuels as detailed above can help the country address three issues simultaneously: meeting its population's demand in liquid fuels, decreasing its carbon dioxide emissions and reducing the country's dependency on imported fuels with financial and potentially political implications for India.

India has the potential to produce large volumes of environment friendly biofuels to significantly decrease its dependency on imported oil particularly for transportation purposes. The country has large dry/waste lands which can be used for this purpose. It also has the right type of carbon-neutral crop for such cultivation, Jatropha, which does not require farmlands to encourage conversion of food-producing farms for its production. As such, its seeds are very rich in oil making it suitable for biodiesel production. Given Jatropha oil can be used directly after extraction, the production process of this type of biofuel is significantly less energy-intensive than that of other crops currently used globally (e.g., corn and sugar cane). Production of biodiesel from Jatropha is already underway in India although its production is still limited. Jatropha-based biofuel can well be a viable solution to address both energy requirements of the Indians in liquid form, including for transport fuel, and reduce India's greenhouse gas emissions without lowering the living standards of its population under a certain condition. Hence, the correct process to turn biofuel production into an environment friendly process has to be followed to make its product a suitable alternative to liquid fossil energy. ✪

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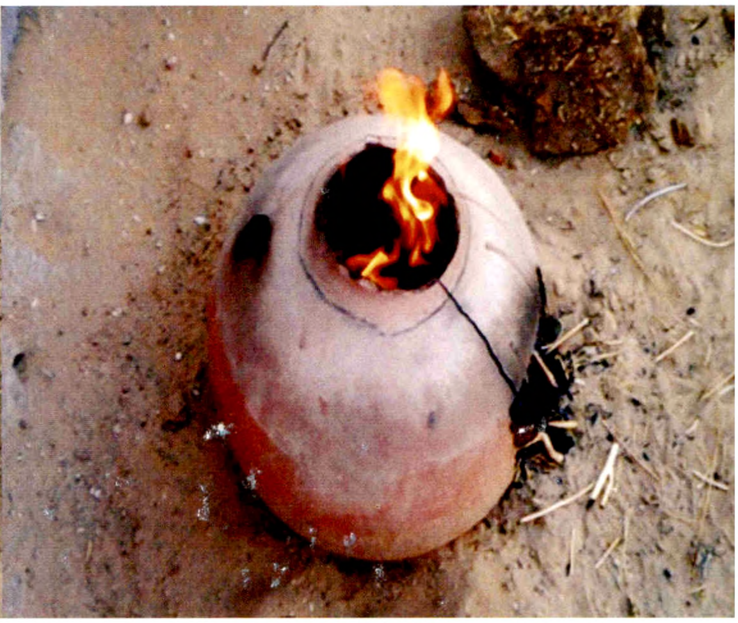
Improved Chulha

Cooking Efficiently

More than 86 per cent of rural households in India use traditional *chulhas* (woodstoves) for their cooking purpose. Traditional *chulhas* are less efficient and produce a lot of smoke and thermal stress, which cause serious problems for human health and environment. The JAGRITI MODEL mud pot based *chulha* not only has an efficient design, it is portable and the cost is lower.

Manoj Gattani and G Sanjay Kumar

Traditional *Chulha* - heat spreading out of the *Chulha*



Improved Chulha - heat is centralised at the bottom of the pot

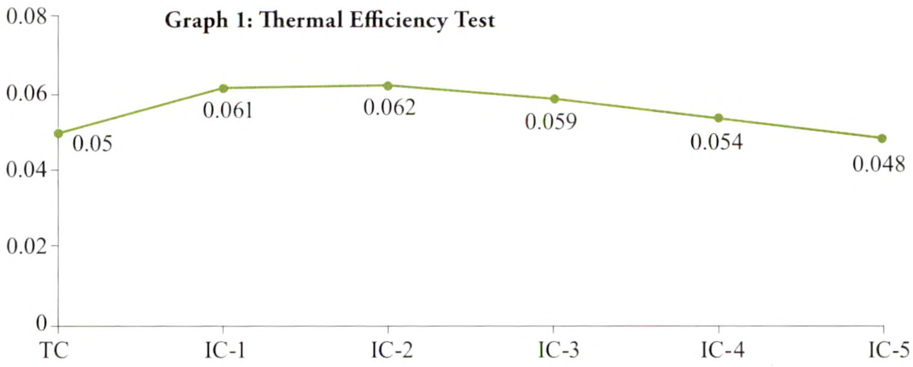
Instead of the rectangular shape of the traditional *chulhas*, a concave shape was selected for the JAGRITI MODEL improved *chulha*. Because of the concavity, the size of the fuel chamber is bigger and better thermal efficiency is achieved since the rate of fuel consumption is increased. Five types of models, IC-1, IC-2, IC-3, IC-4 and IC-5 of different fuel chamber diameters were tested. It was found that a *chulha* having diameter of 19 cm, i.e. IC-2 is the most efficient among all.

EXPERIMENTAL SETUP

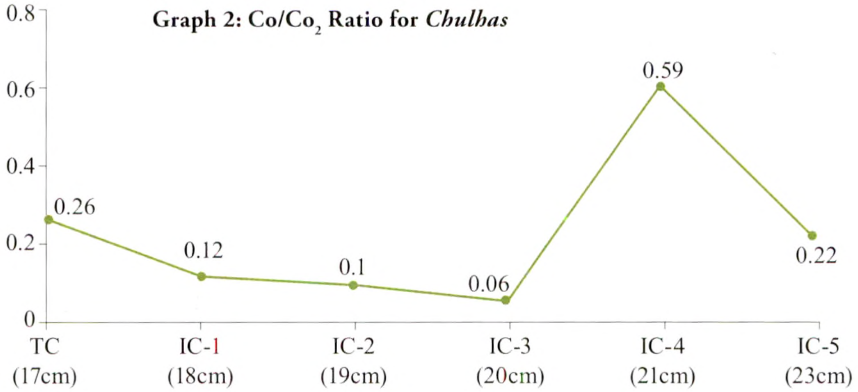
Total five types of tests were conducted to check thermal efficiency and emission of gases along with field cooking test, thermal stress test and fuel efficiency test. One month old cow dung cakes were taken as fuel for various tests. Moisture content of these cakes was calculated to be 15.15 per cent and weights of these cakes ranged from 200 to 450 grams. All the tests were conducted at full load of the *chulha*. For thermal efficiency test, water was taken into 5 lt of SS pot and heated to 65 °C from room temperature. Bajra roti was prepared in the field cooking test.

RESULTS AND DISCUSSION

As the diameter of fuel chamber of improved *chulha* increases from 17 cm to 19 cm, the efficiency of the *chulha* also increases. The thermal efficiency for IC-2 is 8.3 per cent , which is 20.4 per cent more than traditional *chulha*. For improved *chulha* having diameter greater than 19 cm i.e. IC-3, IC-4 and IC-



Graph 1: Thermal Efficiency Test



Graph 2: Co/Co_2 Ratio for *Chulhas*

> **Total five types of tests were conducted to check thermal efficiency and emission of gases along with field cooking test, thermal stress test and fuel efficiency test.**

5, with diameters of 20 cm, 21 cm and 23 cm, respectively, efficiency reduces because of heat losses. IC-2 *chulha* is also found to be better in *roti* preparation test as it takes 23.8 per cent less time than traditional *chulha*; IC-2 cooked 52.5 g *rotis* per minute whereas the traditional *chulha* cooked only 40.0 g of *rotis* per minute. Thermal stress was found more in traditional *chulha* because of greater heat loss from sides and inlet than in IC-2 *chulha*. Because of the heat coming out from sides and inlet more incidents of hand burning, utensils damage and other accidents were found with the use of traditional *chulha* than with improved *chulhas*.

Generally, heat efficiency is proportional to heat intensity but in case of improved *chulha* this statement is not always true. In case of IC-5 though heat intensity is maximum the heat efficiency is found to be minimum and even less than that of the traditional *chulha*. This happens because when diameter of fuel chamber is increased the fuel consumption rate increases. At full load conditions, more fuel is available to burn and more loss takes place. Because of more availability of fuel for burning, smoke production rate increases. In IC-4 and IC-5 smoke tends to come out from the mouth (inlet) and it is estimated that initially around 15-20 per cent of total smoke comes out from the mouth of the *chulha*. For proper air circulation and removal of ash from burning the cakes, air is to be blown from the mouth towards the *chulha's* inlet intermittently. While performing such operations with traditional *chulha* smoke enters the eyes and nose, these problems are sought to be minimised with the concave shaped inlet of the improved *chulha*.

CONCLUSION

After analysing all parameters and factors like water boiling test, roti preparation test, thermal stress test etc. it is concluded that IC-2 i.e. improved mud *chulha* with diameter 19 cm, height 23 cm and outlet mouth diameter 17 cm is the most efficient among all improved *chulhas* for regular cooking. ❂

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OFFSHORE WIND POWER IN INDIA

OPPORTUNITIES AND CHALLENGES

The need of the hour in India is a clean and renewable sources of energy, in which offshore wind power can play a major role. The objective of this study is to understand the prospects of offshore wind power in India and the related challenges.

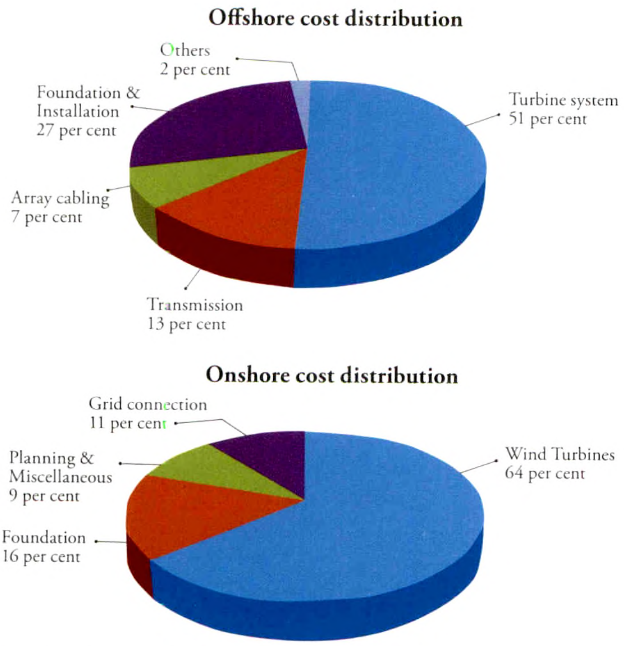
Siddharth Arora

The electricity demand-supply mismatch in India has been at a peak these last few years. The country depends on its coal based thermal power stations to quench its rocketing demand. With the economy realising 7-8 per cent growth rates, India is looking for means to enhance its generation capabilities. Added factors that the country must consider are international pressure and a moral responsibility towards the environment, before it chalks its electrical infrastructure plans.

The objective of this study is to understand the prospects of offshore wind power in India and the related challenges. A detailed study of various European countries, that have already gained excellence in offshore wind power projects has been done and based on that study, different cost reduction potentials in India have been listed. The study also suggests a few possible potential sites, a list of probable clearances required for setting up of offshore wind farms in India, and the need for a regulatory framework for such high capital cost projects.

INTRODUCTION

About 53 per cent of electric power in India is generated from coal and lignite based steam thermal plants, which contribute a lot to air pollution. The need of the hour is a cleaner and renewable source of energy, in which offshore wind power


Offshore cost distribution

Onshore cost distribution

Cost distribution of offshore and onshore wind power projects

can play a major role. The offshore wind power potential for India has been estimated as 15000 MW (<60m depth) (Dolf Gielen, Nathalie Trudeau, Dagmar Graczyk and Peter Taylor, October 2009). There are many potential sites in Indian waters and still this huge potential remains untapped.

Nothing much has been done in this field in India as the capital cost of such projects is very high and the necessary supply chain is also not established. There is lack of data and it is not clear from which departments clearances are required.

ADVANTAGES OF OFFSHORE WIND

The offshore wind carries certain advantages over the onshore wind.

Greater area available for setting up large projects: One primary reason for moving towards offshore projects is the lack of suitable wind turbine sites on land.

Higher wind speed than onshore locations: Wind speeds are significantly higher at offshore locations. An increase of about 20 per cent some distance away from the shore is not uncommon.

Lower turbulence intensities: Wind is less turbulent at sea than over land which results in lower mechanical fatigue load and thus longer lifetime for the turbines.

More consistent wind speed: It is a frequent misunderstanding that wind power generation requires very stable winds. In most wind turbine sites around the globe, in fact, the wind varies substantially, with a high occurring rather infrequently, and low winds occurring most of the times. At sea, periods of complete calm are generally extremely rare, and quite short-lived. Thus the effective use of wind turbine generating capacity will be higher at sea than on land.

> **Not much has been done in the offshore wind field in India as the capital cost of such projects is very high and the necessary supply chain is also not established.**

Less visual impact: As these sites are located far from land they have less visual impact which helps with public acceptance issues.

Close to load centres: The Offshore wind farms are usually located near to the cities and load centres and thus transmission losses are minimised.

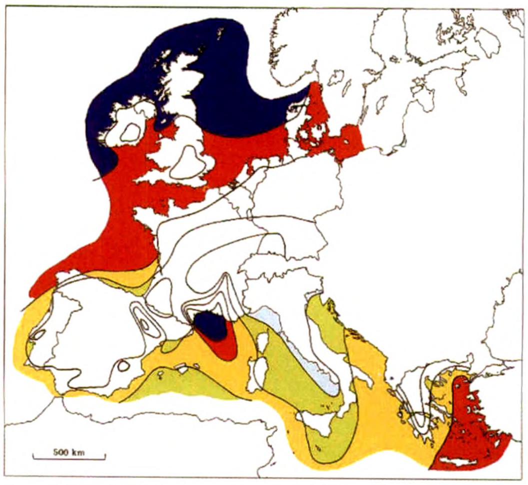
Short gestation period: A mega size and ultra mega size thermal or hydro power project may have a gestation period of 3-6 years whereas as an offshore wind project has a gestation period of 1-2 years, depending upon depth and distance from shore.

The foundation and installation cost in offshore projects is much higher as compared to that of onshore. It can be as high as up to 25-30 per cent of the project cost.

CHALLENGES

The offshore wind power faces many challenges.

Cost: The capital cost of such projects is very high as compared to onshore wind power projects. The average capital cost in Europe in 2006 was around 2.1 million € per MW at 37.5 per cent capacity utilisation factors (CUF) (www.wind-energy-

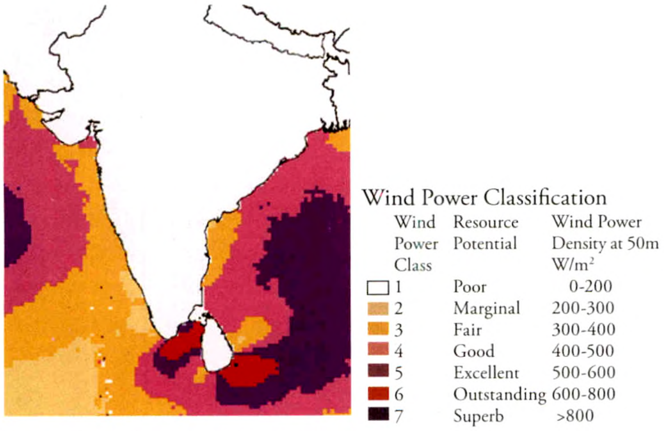


Wind resources over open sea (more than 10 km offshore) for five standard heights										
	10 m		25 m		50 m		100 m		200 m	
	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}
🟦	> 8.0	> 600	> 8.5	> 700	> 9.0	> 800	> 10.0	> 1100	> 11.0	> 1500
🟥	7.0-8.0	350-600	7.5-8.5	450-700	8.0-9.0	600-800	8.5-10.0	650-1100	9.5-11.0	900-1500
🟧	6.0-7.0	250-300	6.5-7.5	300-450	7.0-8.0	400-600	7.5- 8.5	450- 650	8.0- 9.5	600- 900
🟩	4.5-6.0	100-250	5.0-6.5	150-300	5.5-7.0	200-400	6.0- 7.5	250- 450	6.5- 8.0	300- 600
⬜	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 6.0	< 250	< 6.5	< 300

Fig 1. Wind resource map of Europe

the-facts.org), however, the average capital expenditure has doubled in UK in the last 5 years mainly because of commodity prices, less accessible locations and other bottlenecks (Reuters). The cost in India might be on the higher side because of various factors like absence of Turbine Installation Vessels (TIVs), construction support vessels, lack of sub-structure manufacturers, lack of trained man power etc.

> **The offshore wind energy also needs dedicated frameworks and policies for its promotion and to establish a presence in the Indian power market.**



Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50m W/m^2
☐ 1	Poor	0-200
■ 2	Marginal	200-300
■ 3	Fair	300-400
■ 4	Good	400-500
■ 5	Excellent	500-600
■ 6	Outstanding	600-800
■ 7	Superb	>800

Fig 2. Wind density at 50 m height

DATA: The data required for the calculation of offshore wind potential and identification of suitable sites is not available. The data can be divided into 2 parts:

- Wind resource map
- Bathymetric data

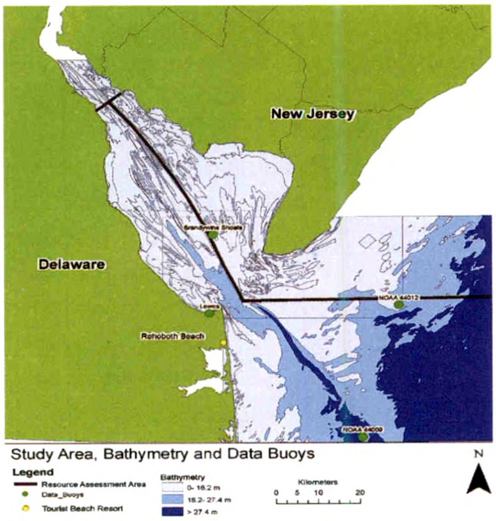


Fig 3. Bathymetric data for Delaware, USA

Wind resource map: This consists of the wind speed and wind density at certain levels above the sea. Figure 1 shows the wind resource map for Europe.

Centre for Wind Energy Technology (C-WET) is now monitoring potential sites for offshore projects but at present there is no resource map available. However, some data was available from the website of Remote Sensing System (www.remss.com) which has given monthly and annual information of offshore wind speed and density for the world. Figure 2 shows the annual wind density map for India at 50 m height. Similar maps have been obtained for wind speed and density at 50 and 10 m height.

The map in Fig 2 shows some potential sites in the Gulf of Kutch and the region between Tamil Nadu and Sri Lanka. C-WET has done a study at the Kanyakumari and Rameshwaram region but no study has been done inside the sea, which is the exact location for an offshore wind farm.

Bathymetric Data: This data gives the information about the sea depth at various positions. Figure 3 shows the bathymetric data for offshore wind power assessment at Delaware, a US state.

At present there is no such data available for the Indian sub-continent and no such data was available from any other source.

After preparing the necessary wind resource map and obtaining the bathymetric data, they are compiled to identify the potential areas. There are particular zones like the shipping lanes, military exercise areas, dredging regions, oil exploration areas, exclusive fishing zones, areas with underlying submarine communication cables, and dumping grounds for ammunition, explosives and other hazardous material that have to be considered before finalising the exact potential sites.

Regulatory and policy framework: The Electricity Act 2003 defines various sections like, sec. 3, sec. 61 and sec. 86 (1)(e) which mandate the policy formulation and optimal use of all resources including renewable sources of energy.

Jawaharlal Nehru National Solar Mission (JNNSM) is a dedicated framework for the promotion of the solar energy. Similarly "India Hydrocarbon Vision-2025" is a strategical model for oil exploration in the Indian sedimentary basins. The offshore wind also needs such dedicated frameworks and policies for its promotion and to establish a presence in the Indian power market.

COST REDUCTION POTENTIALS

The cost of the offshore projects can be brought down in the Indian market with various cost reduction factors like:

Table 1. Probable list of clearances required

Agency	Issues
Ministry of Environment and Forests	Environment Impact Assessment Forest clearance CRZ clearance
State Government	Clearance for working under approved CZMP
Ministry of Defence	Security clearance for vessels in Indian waters
Coast Guard	Security and hazards issues of offshore installation
Directorate General of Shipping	Approval for hiring foreign vessels
Directorate General of Lighthouse and Lightships	Clearance for onshore construction
Directorate General of Hydrocarbons	Clearance for operating outside oil and gas exploration zones
Ministry of Petroleum and Natural Gas	Clearance for operating outside oil and gas exploration zones
Ministry of Civil Aviation	Aviation safety
Department of Telecommunication	Clearance for operating outside sub-sea cable zones
Chief Conservator of Forests	Forest clearance
State Pollution Control Board	Pollution control clearance
Directorate of Explosives	Importing/stocking explosives
Geology and Mining Department	Environment hazards
Ministry of Finance	Issues on tax, custom, excise
District Commissioner	Land use permission Public hearing for environment clearance Law and order issues
Land Revenue Officer	Purchase/use of land
Commissioner of Income Tax	Income taxation
Registrar of Companies	Registration of company Statutory returns
Commissioner of Customs and Excise	Import/export
Reserve Bank of India	Payment in foreign currency

Cheap labour, material and production cost: A report published by Global Wind Energy Council (GWEC) and the Indian Wind Turbine Manufacturers Association (IWTMA) on the wind energy industry in India reveals that turbine prices have always been lower than the global average due to lower labour and production cost in the country.

Economies of scale: Another factor favouring the cost reduction is the mass production of turbines. The current annual production capacity of onshore wind turbines manufactured in India is about 3000-3500 MW, including turbines for the domestic as well as for the export market. With the new market entrants, it is expected that the annual production capacity will rise to 5000 MW per year by 2015.

> **Another factor favouring the cost reduction is the mass production of turbines. With the new market entrants, it is expected that the annual production capacity will rise to 5000 MW per year by 2015**

Learning-by-doing: The process of gaining experience from a project and applying it in an improvised manner to other projects count for learning-by-doing. At Horns Rev and Nysted wind farms (Denmark), the world's two largest offshore wind farms built until the end of 2003, for the first time purpose-design ships were used for turbine erection, both by the same contractor.

Horns Rev was build in 2002 and 80 turbines were installed in the farm. The average installation time was reduced from over 3 days per turbine for the first few turbines to a final average of 1.4 turbines per day. This time was greatly reduced by learning-by-doing.

The Nysted wind farm was installed in summer of 2003 and 72 turbines were installed in the farm. The installed capacity doubled once with the second wind farm. The learning curve shows that the installation time decreased by 23 per cent. As the equipments are based on day-rates, the decrease in installation time can be translated into cost reductions.

CLEARANCES REQUIRED

On the basis of clearances required for an onshore wind farm in India and for setting up offshore oil rigs, as well as taking into account the Coastal Regulation Zone (CRZ), the 1982 UN Convention on the Law of Sea and the international experience of countries like UK, Denmark and Germany, a probable list of clearances required for an offshore wind farm is prepared. Table 1 gives a probable list of clearances required for setting up of an offshore wind power farm in India.

CONCLUSION

The need of the hour is a clean and sustainable energy source and offshore wind power can play a significant role. In India offshore wind power still remains untapped and given the power deficit in the country this huge potential needs to be tapped. ✪

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Biodiesel from Microalgae

A Potential Renewable Biofuel

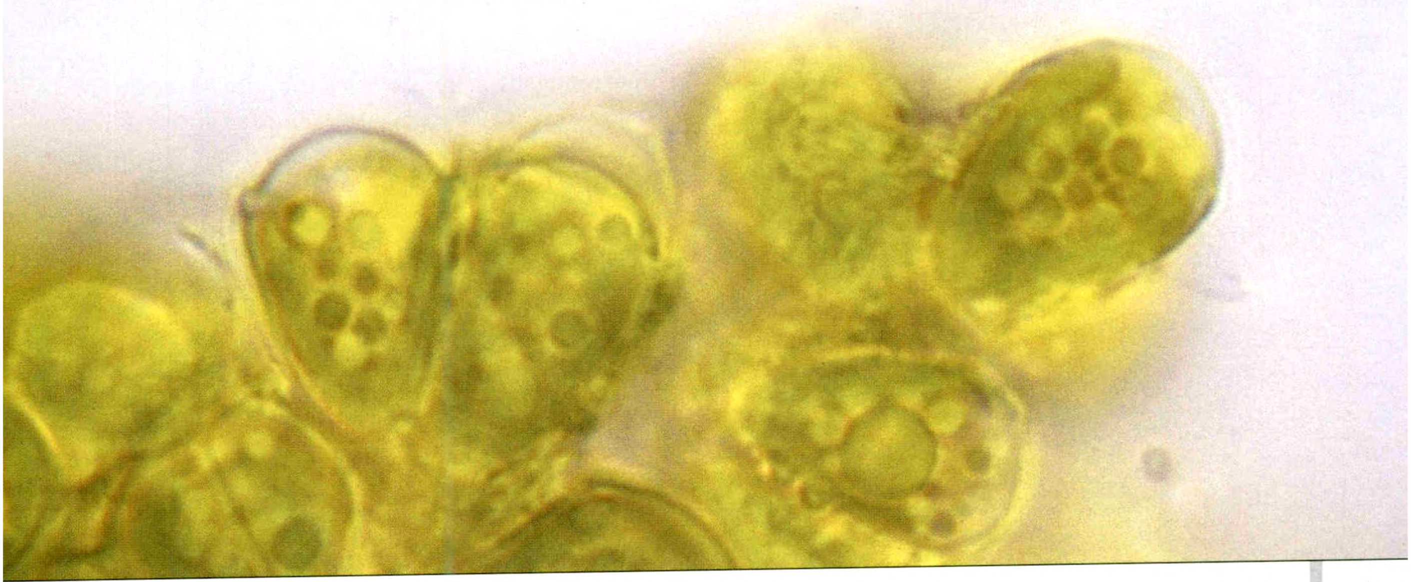
Multi disciplinary efforts are being made to generate biofuel from several sources and recent advancement in this regard includes microalgae, a second generation biofuel feedstock based bio-diesel. It has potential because of its higher productivity coupled with high oil content.

M Arumugam, A Agarwal, M C Arya and Zakwan Ahmed

In the present world scenario, bio-diesel has been accepted as a clean alternative fuel and after the Copenhagen Summit 2009, countries have fixed targets for carbon emission cut, which requires stringent steps in the energy sector to keep the environment clean while maintaining good economic growth. In fact, 85 per cent of the energy, which we use is obtained from the fossil fuels as energy source in the form of oil, coal and natural gas (Ministry of Petroleum and Natural Gas, 2006). India's current consumption of oil is about 114 million tonnes per year, 75 per cent of which is imported. About 112 million tonnes of oil is consumed by the transport sector. India burns about 450 million barrels of diesel compared to 84 million barrels of petrol annually (Growdiesel Consortium, 2008). The alarming common concern today is that the natural source of fossil fuel is finite and it is depleting very rapidly due to uncontrolled consumption. Energy security has become a national issue and steps need to be taken to seek viable alternatives in the form of renewable energy to meet the future needs.

India is committed to the use of renewable bio-energy sources to supplement its energy requirements. The Planning Commission of India brought out an extensive report on the development of biofuels in the year 2003. The National Biodiesel Commission was set up to look exclusively into issues pertaining to bio-diesel and the development of *Jatropha curcas* as feedstock for bio-diesel production. Blending target of ethanol (10 per cent) and bio-diesel (20 per cent) with petro-diesel were proposed by 2011-12 (National Biodiesel Commission, 2008).

To achieve the national target of 20 per cent blending, the country requires about 13.4 million tonnes of bio-diesel. Multi disciplinary efforts have already been made to generate biofuel to achieve the target from several sources that are primarily a first generation feedstock. Recent advancement in this regard includes microalgae, a second generation



biofuel feedstock based bio-diesel. It has potential because of its higher productivity coupled with higher oil content than the terrestrial oil seed crops. Also, it does not interfere with the food chain or compete with natural resources and inputs as compared to first generation biofuel sources. Microalgae is a photosynthetic organism, which converts sunlight, water and carbon dioxide to sugars, from which macromolecules, lipids and triacylglycerols can be obtained. Microalgae are wide spread in diverse environmental niches, which include fresh water, brackish, marine and hyper saline with ranges of temperature and pH.

Defence Institute of Bio-Energy Research (DIBER), Defence Research and Development Organisation (DRDO), Haldwani has undertaken a project 'DRDO-Army Bio-diesel Programme' to fulfil the energy security. In this regard research and development (R&D) on algal biofuel has been initiated with the prime objective to identify an ideal locally adapted strain, which can withstand the varying geo-physical environmental conditions i.e. temperature (day/night), and higher altitude (5500') in order to produce bio-diesel on a large scale to meet the future requirements. Therefore work has been taken up to collect the locally adapted algal strains, culture them in open pond condition and evaluate the productivity for oil content with less energy consuming harvesting technique.

Bio-diesel from algae: A biological concept

Algae, a primitive form of plant, more commonly referred to as 'seaweed' multiplies very fast in nature. Algae possess similar photosynthetic mechanism as that of higher plants with better conversion of solar energy into natural oil. It takes place as a result of more efficient access to water, carbon dioxide and other nutrients. Because of these exceptional reasons, microalgae are capable of producing manifold oil per unit area of land, compared to conventional terrestrial oilseed crops (Table 1). Chemically algal biomass constitutes about 60 per cent natural stored lipids and rest protein, carbohydrate and other nutrients. Because of its unique ability of faster multiplication with higher lipid content, it is highly significant to exploit these tiny microalgae for the production of bio-diesel.

Table 1. Micro algae oil potential compared to other terrestrial oil seed crops

Crop	Oil per cent	Oil yield (L/ha/yr)
Corn	3.1- 5.7	172
Soybean	18-22	446
Canola/Mustard	40-45	1,190
Jatropha	20-40	1,892
Coconut	17	2,689
Oil palm	23	5,950
Microalgae	30 (Min. Scenario)	58,700
Microalgae	70 (Max. Scenario)	1,36,900

(An estimate as reported by Chisti, 2007, Biotechnol. Adv., 25, 294-306)

Advantages of microalgae over terrestrial oil seed crops

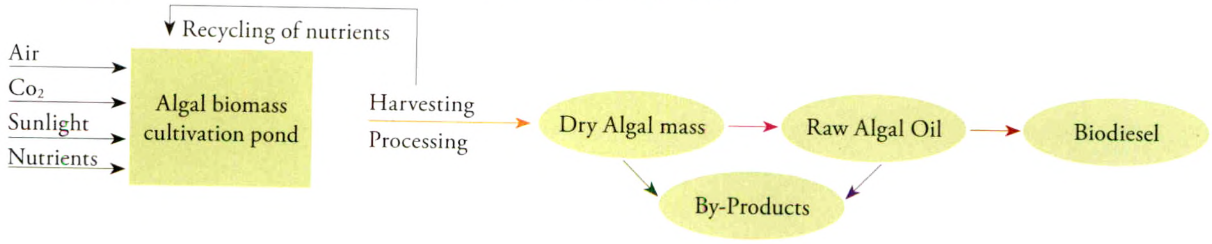
Microalgae can be a potential source of biofuel feedstock due to the following unique properties:

- Synthesise and accumulate large quantities of neutral lipids (20 to 50 per cent)
- Renewable with higher multiplication rate (Cell doubling time varies from 8-24 hrs)
- Thrive in saline/brackish water/coastal seawater
- Utilise nutrients from variety of agricultural, industrial and municipal wastewater
- Sequester carbon dioxide from flue gases emitted from fossil fuel-fired power plants and other sources, thereby reducing emission of major greenhouse gases
- Produces valuable by-products (Proteins, polysaccrides, pigments, animal feed, manure, hydrogen and biopolymers)
- Grows successfully throughout the year with high biomass productivity

Algal biomass production

Commercial algal cultivation facility employs both open pond and closed cultivation system. Open pond has varying capacity, shapes and sizes depending upon the existing natural resources in terms of land and water. However a water depth of 15-30 cm is optimum for algal cultivation because it facilitates the uniform penetration of sunlight to the bottom. In open pond system, one important aspect is

Fig 1: Different stages and process involved in algal biomass production for biodiesel



> **Bio-diesel standards have been laid down at national and international levels. At the national level, bio-diesel (B-100) should match with IS-15607-2005 specifications.**

continuous agitation of growing medium to avoid settling of algal mass and to achieve higher growth rate. Agitation is generally performed using a mechanical pedal wheel. The overall algal growing condition involves the following general criteria as illustrated in Fig 1.

In general the ideal algal strain (locally adapted strain with significant amount of oil content) is selected for mass culturing based on adaptability, biomass productivity, lipid/triacylglycerol (TAG) content and fatty acid composition. The influence of environmental factors on the accumulation of neutral lipids is high in open field conditions. Therefore it is important to exploit the locally adapted algal strains instead of the strain already screened for oil yield. Keeping this in view more than 57 algal strains were collected from in and around Pithoragarh (5500' altitude) and evaluated for their adaptability. Two algal strains namely *Scnedesmus bijugatus* and *Chlorococcum humicola* were found promising for biofuel due to their good biomass and oil productivity. The biomass productivity of 150 mg/lit/day and total lipid productivity of 17.7 mg/lit/day was observed for *Scnedesmus bijugatus* whereas for *Chlorococcum humicola* the values were 70 mg/lit/day and 7.0 mg/lit/day, respectively.

In general, open pond systems (Fig 2) are dominated by two to six algal species with a range of advantages like rapid growth, resistance to predators and tolerance to high level of dissolved oxygen in addition to being economical. The algal stains growing at Pithoragarh in open pond condition also show high variability under microscope (Fig 3).

Standardised cost effective growth medium

Nutrition is a vital factor for the growth and development of all photosynthetic organism including algae. Therefore, It is important to have a good growth medium, which is easily available and cost effective for large scale cultivation of algal mass for bio-diesel. A series of experiments were conducted at DIBER to evaluate the effect of different nutrient compositions on algal mass growth for standardisation of a low cost growth medium because analytical grade chemicals which are generally used are needed in large quantities and are costly. Algae grow on agricultural, municipal and industrial wastewater easily by utilising the nutrition available in the wastewater. Since the nutrient content of farmyard manures (FYM) is comparable with that of municipal waste it is being used as an alternative source of nutrition instead of a costly synthetic medium for algal growth. A set of experimental studies revealed that 10 per cent FYM extract supplemented with 0.1 per cent urea was found as good as the synthetic growth medium CHU13 in terms of algal biomass growth.

Biodiesel quality and standards

A high level of long chained fatty acid esters increases the viscosity of the bio-diesel, leading to more stress on the diesel injection pump and incomplete fuel combustion, as the droplets formed in the cylinder tend to be larger. The proportion of convertible oil in the algae lipid fraction is a major problem overlooked in algae bio-diesel R&D. It has been reported that the fatty acid composition (chain length, saturation) varies significantly between different algae species and genera, and by environmental factors such as illumination, temperature, nutrition and cabon dioxide concentration, etc.

Bio-diesel standards have been laid down at national and international levels. At the national level, bio-diesel (B-100) should match with IS-15607-2005 specifications

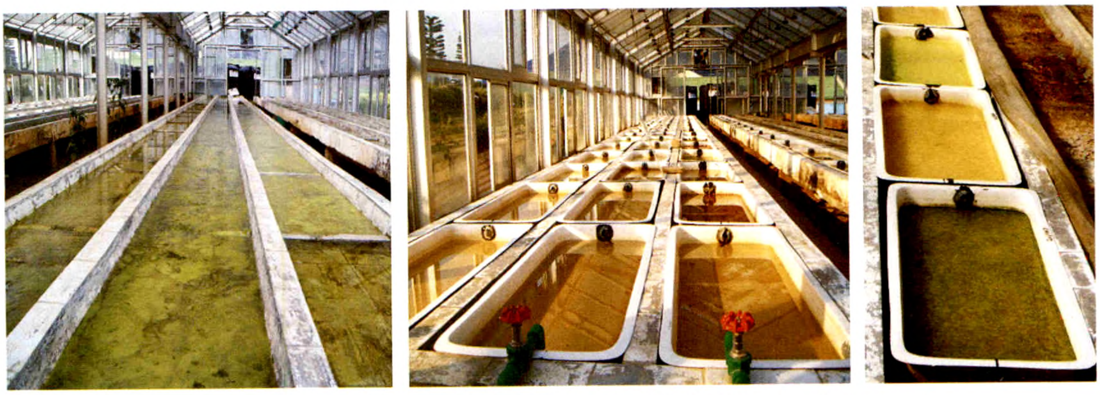


Fig. 2. Algal Bio-Mass production facility at DIBER Field Station, Pithoragarh.

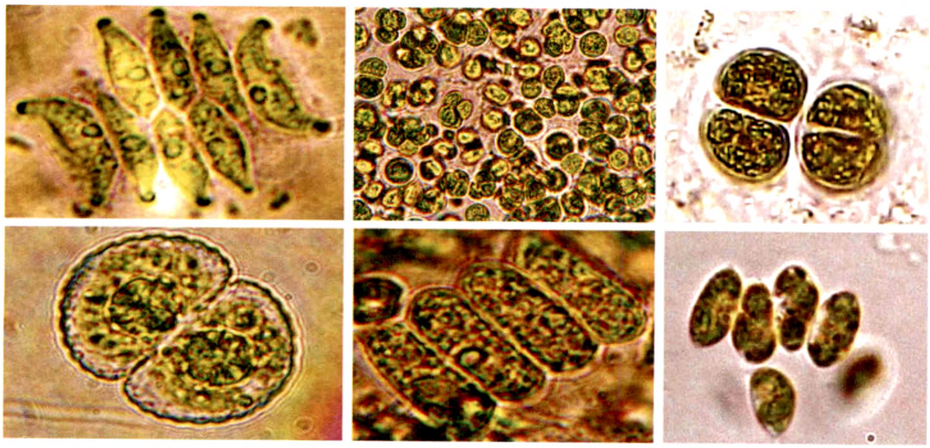


Fig 3. Morphological variation observed in algal cultures grown in open

A. *Scenedesmus acuminatus*
B. *Chlorococcum humicola*
C. *Chroococus giganteus*
D. *Closterium decorum*
E. *Scenedesmus perforatus*
F. *Scenedesmus bijugatus*

and at international level ASTM 6751 (USA) or EN 14214 (European countries) specifications.

Economics of algal biofuel production

Algal biomass multiplication, harvesting techniques and trans-esterification process determines the economy of biofuel production along with other related factors. As per an economic study conducted for open raceway pond at NREL (USA) total production cost ranged from USD 25 per gallon for low productivity (10 g/sq m/day at 15 per cent TAG content) to USD 2.50 per gallon for high productivity (50 g/sq m/day at 50 per cent TAG content). It is only an estimate, certainly high productivity will minimise the cost of algae driven biofuel to make this technology economically competitive and viable in the global market.

Limitation of algal biodiesel production technology

It is a well known phenomenon in algal mass based bio-diesel that harvesting and drying of algal mass is a critical step for making this technology economically viable and harvesting alone accounts for 20-30 per cent of the total production cost. Generally chlorella and other microalgal strains being microscopic in nature are difficult to harvest in a conventional way. It will be appropriate to develop an algal strain that facilitates easy harvesting without compromising the oil content. Yet another significant factor, which makes the algal biofuel commercially not viable, is extraction of oil from algal biomass on a large scale. The existing solvent based extraction (or other techniques) no longer supports large scale operations because of high cost, hindering the downstream processing and making the bi-product non-edible. Drying of algal biomass also poses a major challenge towards commercialisation of algal oil because of aquatic (rich water content) nature of algae. Therefore R&D activity in this direction will contribute significantly for the economic use of algal oil to achieve the national target of blend (B20) with petro-diesel.

Future prospects

Microalgae provide an excellent source of lipids for two major reasons. First, microalgae productivity can be an order of magnitude greater than terrestrial vegetation used for biofuel feedstock. Second, the lipid content of microalgae can exceed 70 per cent of their dry mass, although algae with lipid content of around 30 per cent is more common. High productivity combined with high lipid content results in a large amount of lipid that can be harvested annually for bio-diesel production.

The potential benefits of large scale production of microalgae for biofuels are more promising than the concerns raised for utilisation of resources and fresh water with capital investment. Microalgae appear to be one of the best options as a feedstock for biofuel because of their tremendous productivity, ability to use wastewater in production and the valuable by-products that can be produced. Research dealing with improving production systems, identifying ideal microalgae and enhancing biofuel production through genetic engineering and investigating the sustainability of microalgal biofuel is necessary before large scale microalgal biofuel operations are established. ❂

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(The content of this article is part of a presentation made at the International Congress on Renewable Energy - 2010 at Chandigarh during 1-3 December 2010.)

Solar Photovoltaic

Module Tilt Angle Scale

A solar photovoltaic module or solar collector collects the maximum solar radiation when the sun's rays strike it at right angles. An adjustable (tilt angle) solar photovoltaic module mount (south facing in the northern hemisphere and north facing in southern hemisphere) sun tracking mechanism with an appropriate tilt angle measuring scale can be cost effective. In this paper, design of the tilt angle scale for a given site is described.

P K Pahwa, G K Pahwa and S K Grover

A solar photovoltaic (PV) module generates more electrical power when more sunlight power incidents on it. The sunlight power incident on a module depends not only on the power contained in the sunlight but also on the angle between the module and the sun's rays. When the sun's rays fall normally on the module's surface, the incident sunlight power is maximum. The amount of sunlight power incident on the module's surface is the component of the incoming sunlight power perpendicular to the module's surface. Figure 1 shows how to calculate the sunlight power incident on a module's surface.

$S_{module} = S_{incoming} \text{Sin } (\alpha+\beta)$

Where

$S_{incoming}$ is the incoming sunlight power, S_{module} is the incident sunlight power on the module's surface, α is the sun's elevation angle and β is the tilt angle of the SPV module.

The sun's position in the sky is defined by two angles: altitude and azimuth. Because of the earth's tilt the path that the sun travels changes throughout the year. It follows its lowest path during the winter solstice (21 December in the northern hemisphere and 21 June in southern hemisphere). Following the winter solstice, the sun traces a progressively higher path in the sky until it reaches its highest path on

Fig 1. Measurement of Sunlight Power incident on SPV Module's surface

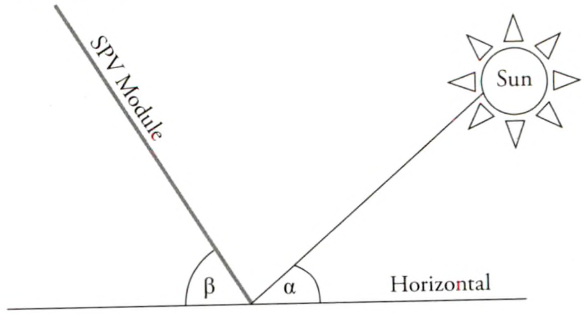


Fig 2. SPV Module Tilt Angle Scale at the Site L= 23.5°N

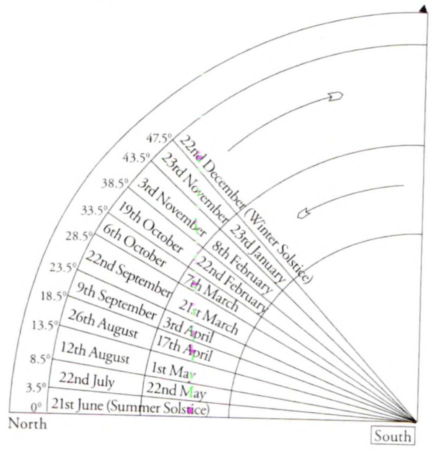


Fig 3. SPV Module Tilt Angle Scale at the Site L= 26°N

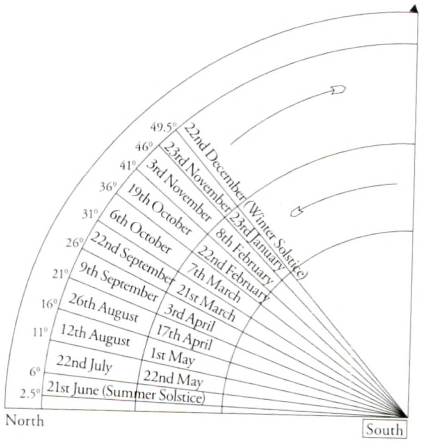
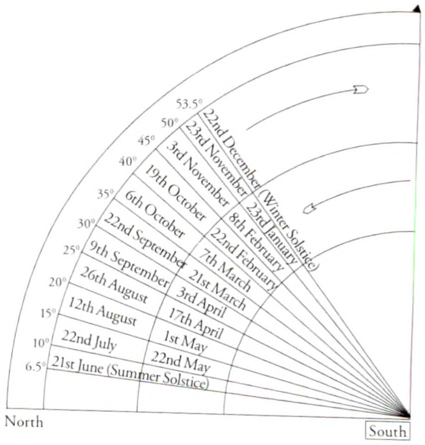


Fig 4. SPV Module Tilt Angle Scale at the Site L= 30°N



> **The sunlight power incident on a module depends not only on the power contained in the sunlight but also on the angle between the module and the sun's rays.**

the summer solstice (21 June in the northern hemisphere and 21 December in the southern hemisphere). Following the summer solstice, the sun's path becomes lower every day until it again reaches its lowest path on winter solstice.

Significance of the Tilt Angle Scale: A solar PV module collects the maximum solar radiation when the sun's rays strike it at a right angle. As the SPV module is tilted away from the perpendicular alignment to the sun's rays, less solar energy is received. However, a small deviation (± 5°) away from the ideal tilt will not affect energy output much. The optimal orientation for a solar energy system depends on the site latitude, date and time of the year. Sun tracking mechanism is not cost effective but an adjustable (tilt angle) solar PV module mount (south facing in the northern hemisphere and north facing in southern hemisphere) can be cost effective. The SPV modules that are used to produce electricity over the year are usually tilted at an angle equal to the latitude of the site. With this tilt angle the modules produce optimum energy output only at equinoxes (on 21 March and 22 September). On other dates the modules do not collect sunlight as efficiently.

To maximise annual electricity of the SPV modules an adjustable (tilt angle) SPV module mount with an appropriate tilt angle scale must be used.

DESIGN OF THE TILT ANGLE SCALE

After deep analysis of the geography of the earth's trajectory around the sun and taking into consideration the data available on the websites: www.timeanddate.com, www.ngdc.noaa.gov and www.rredc.nrel.gov it can be concluded that the optimal tilt angles for the SPV modules at a site in northern hemisphere with latitude L are as follows:

From vernal equinox to autumnal equinox

- L on 21 March and on 22 September (equinoxes)
- (L-5°) on 3 April and on 9 September (2 weeks difference)
- (L-10°) on 17 April and on 26 August (next 2 weeks difference)
- (L-15°) on 1 May and on 12 August (next 2 weeks difference)
- (L-20°) on 22 May and on 22 July (next 3 weeks difference)
- (L-23.5°) on 21 June (summer solstice)

From autumnal equinox to vernal equinox

- L on 22 September and on 21 March (equinoxes)
- (L+5°) on 6 October and on 7 March (2 weeks difference
- (L+10°) on 19 October and on 22 February (next 2 weeks difference)
- (L+15°) on 3 November and on 8 February (next 2 weeks difference)
- (L+20°) on 23 November and 23 January (next 3 weeks difference)
- (L+23.5°) on 22 December (winter solstice)

For example the Tilt Angle Scale for sites 23.5°N, 26°N and 30°N are shown in figures 2, 3 and 4, respectively. Some of the earth's big cities and important solar hubs are at these sites.These lines pass through USA, Egypt, India, portions of Central America, Northern Africa, Sahara Desert, Thar Desert and Saudi Arabia Desert. Mean annual surface albedo value of these sites is about 18 per cent. ❂

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What's that?

Here we familiarise you with some terms which will help you to understand renewable sources of energy better.

Embodied Energy

The embodied energy is quantity of energy required to manufacture a product and supply it to the point of use. It is the sum total of energy necessary from the raw material extraction to the manufacture to the transportation and installation of a product

Geothermal

Heat from the earth. Often thought of as energy from geysers and hot springs. More recently, this term is applied to any heat stored in earth and available as a renewable energy resource.

Biodiesel

Biodiesel is an alternative fuel produced from renewable resources such as plant oils, animal fats, used cooking oil, and new sources such as algae. Biodiesel contains no petroleum, but can be combined in any quantity with petroleum diesel to create a biodiesel blend. Biodiesel blends can be used in most 'compression-ignition' (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulphur and aromatics (the 'diesel' odour). (Biodiesel is not raw vegetable oil.)

Insolation

This is a measure of solar radiation energy received on a given surface area in a given time. Insolation is the solar radiation striking earth or another planet. It is commonly expressed as average irradiance in watts per sq m (W per sq m) or kilowatt hours per sq m per day (kWh per (sq m per day)) (or hours per day). In the case of photovoltaics it is commonly measured as kilowatt hours per year per kilowatt peak rating (kWh per y per kWp). Do not get confuse with insulation.

Solar Constant

The strength of sunlight; 1353 watts per sq m in space and about 1000 watts per sq m at sea level at the equator at solar noon.

Photovoltaics

The process that produces electricity from sunlight. 'Photo' refers to light and 'voltaic' to voltage.

Thin Film

A layer of semiconductor material, such as copper indium diselenide, cadmium telluride, gallium arsenide, or amorphous silicon, a few microns or less in thickness, used to make photovoltaic cells. Commonly called amorphous.

Combined Heat and Power (CHP) Plant

A plant designed to produce both heat and electricity from a single heat source. Note: This term is being used in place of the term 'cogenerator' that was used by the US Energy Information Administration (EIA) in the past. CHP better describes the facilities because some of the plants included do not produce heat and power in a sequential fashion and, as a result, do not meet the legal definition of cogeneration specified in the Public Utility Regulatory Policies Act (PURPA), US.

Solar Noon

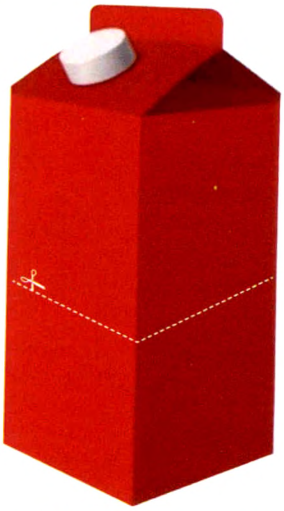
That moment of the day that divides the daylight hours for that day exactly in half. To determine solar noon, calculate the length of the day from the time of sunset and sunrise and divide by two. Solar noon may be quite a bit different from 'clock' noon.

Which Grass Produces more biomass?

Biomass is organic matter available on a renewable basis. Here is an experiment to understand the concept a little better.

Material:

Wheat seeds (garden center, health food store)
Corn seeds (garden center, feed and grain store)
Oats (whole only, not milled) (garden center, health food store)
Potting soil; balance scale
3 fruit juice cartons



		Plant growth and development									
		Germination			**Average height**						
Plant	Date Planted	date of 1st support	date of 10th support	date of 20th support	2 day	4 day	6 day	8 day	10 day	12 day	14 day
Wheat											
Corn											
Oats											

Cut the fruit juice cartons in half. Fill with potting soil, and plant the seeds. Keep moist.

Grow the plants under the sun. Record your results.

After 14 days pull the plants. Wash off the dirt and dry with a paper towel.

Weigh the plants and record. Dry the plants in the sun until they're crisp, and weigh them again.

		Weight	
		fresh weight	dry weight
Test plant	Wheat		
	Corn		
	Oats		

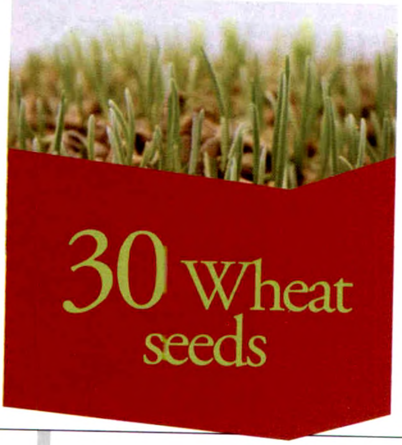
Other Ideas to explore:

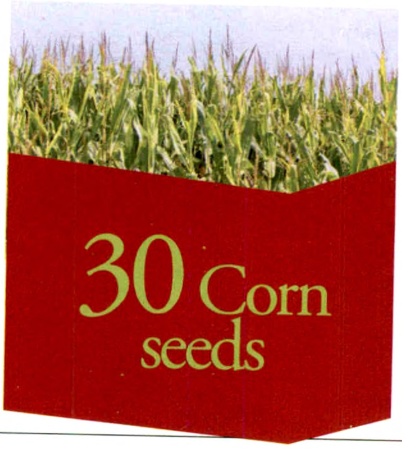
Try burning the biomass produced. Set up and conduct your experiment.

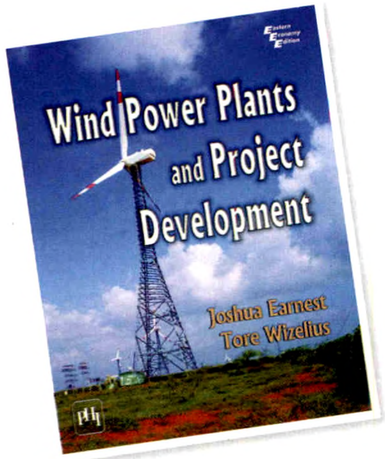
Would the results be better if your plants were allowed to mature?

Do other grasses produce more biomass? (Try using barley, triticale, rice, etc.)

What is done with most of the corn and wheat grown in this country? What might happen if a major portion of our grain was used to produce energy?







Wind Power Plants and Project Development

by **Joshua Earnest and Tore Wizelius**
496 pages
Rs 995.00
Publisher: PHI Learning
2010
ISBN: 978-81-203-3986-6

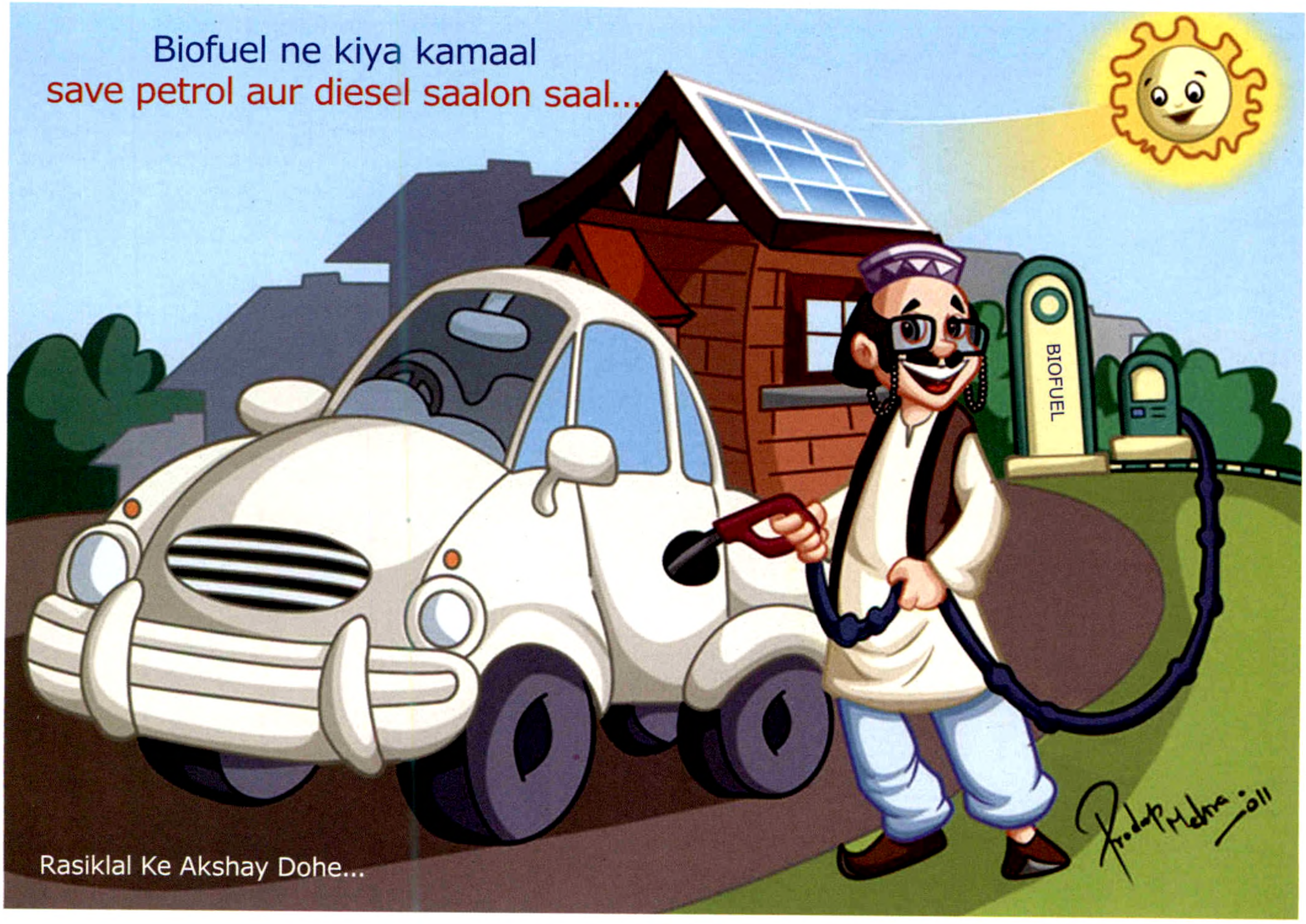
To abate the global climate change, wind power is developing very fast around the world, and India is one of the leading countries in this field. In just a few decades, wind power has developed from an alternative energy source to a new fast growing industrial branch.

This book gives a wide and deep introduction to most aspects of this renewable energy source. Different types of wind turbines and their components are described in detail. The electrical system of wind turbines as well as its adaptation to the grid are emphasised.

The wind climate, the wind resources, the power in the wind and how to find and utilise sites with the best wind conditions, is another area that is discussed in detail. The configuration and selection of wind power plants that suit local wind conditions and the measures to make these plants operate effectively and efficiently, are the other aspects that have been dealt with comprehensively.

To keep India ahead in wind power development, energy policy and promotional strategies are also described in this book.

This book should be a compulsory reading for all who are engaged in the wind power business as well as for the university students pursuing energy studies, policy makers, grid operators, and all those who want to be in the ongoing energy revolution to generate inexpensive and clean power from renewables.


Biofuel ne kiya kamaal
save petrol aur diesel saalon saal...
BIOFUEL
Rasiklal Ke Akshay Dohe...

Forthcoming Events

National

20 - 22 July 2011	Sustainable Energy and Intelligent System Conference (SEISCON 2011) Place: Chennai, Tamil Nadu Organiser: IET-UK YPS Chennai and Dr MGR University Contact: 91 (44) 23782176 or ietseiscon@ietypschennai.org Website: http://seiscon.ietypschennai.org
21 - 22 July 2011	2011- India energy investment Summit Place: Delhi Organiser: naseba Contact: 91 (80) 3028 2233 or ardamans@naseba.com Website: http://nationalenergysummit.com
22 - 23 July 2011	International Conference on Deregulated Environment & Energy Markets (DEEM) Place: Chandigarh, Punjab Organiser: Chitkara University Contact: 91 9463389947 or anu.singla@chitkara.edu.in Website: http://deem2011.chitkara.edu.in
27 - 30 July 2011	International Conference on Emerging Green Technologies (ICEGT 2011) Place: Thanjavur, Tamil Nadu Organiser: Periyar Maniammai University Contact: 91 (43) 62264600 or registrar@pmu.edu Website: www.pmu.edu

International

28 - 29 June 2011	China Energy Management Contract Summit Place: Beijing, China Organiser: Merisis Contact: 86 (791) 2077938 or aaron.yan@merisis-asia.com Website: www.merisis-asia.com
28 - 29 June	FT Global Energy Leaders Summit 2011 Place: London, United Kingdom Organiser: FT Conferences Contact: 44 (20) 78733837 or mike.lundby@ft.com Website: www.ftconferences.com
29 June 2011	The Solar Future: UK Place: London, United Kingdom Organiser: Solarplaza Contact: 31 (10) 2809198 or p.vanderlinden@solarplaza.com Website: www.thesolarfuture.co.uk
29 - 30 June 2011	Offshore Wind 2011 Place: Liverpool, United Kingdom Organiser: RenewableUK Contact: 44 (20) 78782481 or renewableUK@tenalps.com Website: www.renewable-uk.com
5 - 6 July 2011	Smart Grid Security China Place: Beijing, China Organiser: Pyxis Consult Contact: 86 (21) 34292312 or pyxis@pyxisconsult.com Website: www.pyxisconsult.com
5 - 6 July 2011	Cleantech 2011 Place: Tel Aviv, Israel Organiser: Mashov Group Contact: 97 (28) 6273838 or info@mashov.net Website: www.mashovgroup.net
6 - 7 July 2011	UK AD & Biogas 2011 Place: Birmingham, United Kingdom Organiser: The Anaerobic Digestion and Biogas Association, London Contact: 44 (20) 31760503 or enquiries@adbiogas.co.uk Website: www.adbiogas.co.uk
6 - 7 July 2011	Cleantech Summit Place: Geneva, Switzerland Organiser: European Tech Tour Association Contact: 41 (22) 5446090 or info@techtour.com Website: www.techtour.com

Website

National Policy on Biofuels

http://www.mnre.gov.in/policy/biofuel-policy.pdf

The website is a link to the National Policy on Biofuels as brought out by the Ministry of New and Renewable Energy, Government of India. The document includes sections on the vision and goals, definitions and scope, strategy and approach, interventions and enabling mechanisms, quality standards, international cooperation, import and export, awareness and capacity building and institutional mechanisms. The website thus provides comprehensive information about the biofuel policy applicable in the country.

Jatropha World

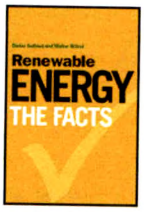
www.jatrophabiodiesel.org

Centre For Jatropha Promotion and Biodiesel (CJP) is a global promoter and producer of jatropha. Its activities have expanded from the desert in Churu, Rajasthan to the entire country and now across the world. The website gives information on various aspects of Jatropha cultivation, programmes, business opportunities and much more.

Biofuels International

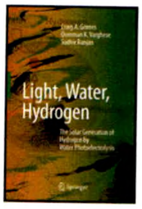
www.biofuels-news.com

Biofuels International is a magazine that is brought out 10 times a year. It is designed to appeal to those who wish to learn and be kept abreast of this increasingly important area, the magazine encompasses, bio-diesel, bio-ethanol, and biomass. Every issue includes in-depth news analysis and features on related subjects, including distribution, handling, storage, equipment and second generation technology. All this and more is available on the magazine website.



Renewable Energy - The Facts

by **Dieter Seifried and Walter Witzel**
Paperback: 251 pages
USD 39.95
Publisher: Earthscan Publications Ltd.
November 2010
ISBN: 1849711607

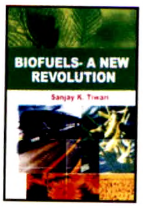


Light, Water, Hydrogen The Solar Generation of Hydrogen by Water Photoelectrolysis

by **Craig A Grimes, Oomman K Varghese and Sudhir Ranjan**
Hardcover: 546 pages
Euro 110.95
Publisher: Springer
2008
ISBN 978-0-387-33198-0

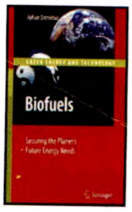
Indian Wind Atlas

By **Sreevalsan E, Siddarth Shankar Das, Sasi Kumar R, Arivukkodi G and Jake Badger**
Rs 5,000
Publisher: Centre for Wind Energy Technology (C-WET), Chennai
2010
ISBN: 978-81-909823-0-6



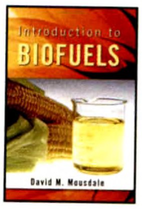
Biofuels: A New Revolution

by **Sanjay K Tiwari**
288 pages
Rs 775
Publisher: Pearl Books
2010
ISBN: 93-80191-40-9



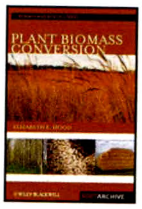
Biofuels: Securing the Planet's Future Energy Needs/ Edition 1

by **Ayhan Demirbas**
Paperback: 346 pages
USD 139.00
Publisher: Springer-Verlag New York, LLC
November 2010
ISBN-13: 9781849968140
ISBN: 1849968144



Introduction to Biofuels/ Edition 1

by **David M Mousdale**
Hardcover: 455 pages
USD 119.95
Publisher: CRC Press
August 2010
ISBN-13: 9781439812075
ISBN: 1439812071

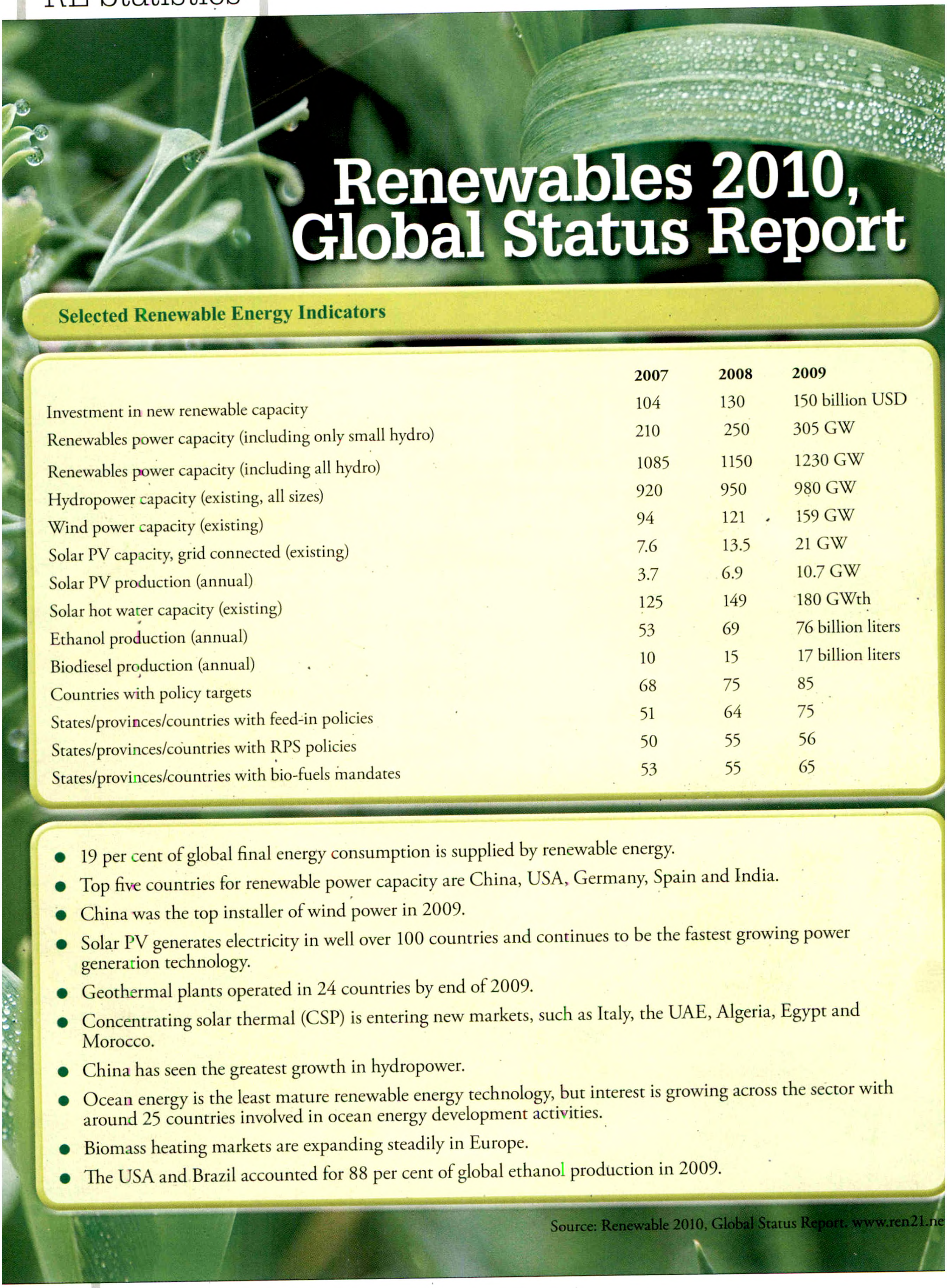


Plant Biomass Conversion

by **Elizabeth Hood, Peter Nelson and Randy Powell**
Hardcover: 376 pages
USD 199.99
Publisher: Wiley
22 March 2011
ISBN: 0813816947

The Handbook of Biomass Combustion and Co-firing

by **Sjaak van Loo (Editor) and Jaap Koppejan (Editor)**
Paperback: 442 pages
USD 84.95
Publisher: Earthscan Publications Ltd.
August 2010
ISBN: 1849711046



Renewables 2010, Global Status Report

Selected Renewable Energy Indicators

	2007	2008	2009
Investment in new renewable capacity	104	130	150 billion USD
Renewables power capacity (including only small hydro)	210	250	305 GW
Renewables power capacity (including all hydro)	1085	1150	1230 GW
Hydropower capacity (existing, all sizes)	920	950	980 GW
Wind power capacity (existing)	94	121	159 GW
Solar PV capacity, grid connected (existing)	7.6	13.5	21 GW
Solar PV production (annual)	3.7	6.9	10.7 GW
Solar hot water capacity (existing)	125	149	180 GWth
Ethanol production (annual)	53	69	76 billion liters
Biodiesel production (annual)	10	15	17 billion liters
Countries with policy targets	68	75	85
States/provinces/countries with feed-in policies	51	64	75
States/provinces/countries with RPS policies	50	55	56
States/provinces/countries with bio-fuels mandates	53	55	65

- 19 per cent of global final energy consumption is supplied by renewable energy.
- Top five countries for renewable power capacity are China, USA, Germany, Spain and India.
- China was the top installer of wind power in 2009.
- Solar PV generates electricity in well over 100 countries and continues to be the fastest growing power generation technology.
- Geothermal plants operated in 24 countries by end of 2009.
- Concentrating solar thermal (CSP) is entering new markets, such as Italy, the UAE, Algeria, Egypt and Morocco.
- China has seen the greatest growth in hydropower.
- Ocean energy is the least mature renewable energy technology, but interest is growing across the sector with around 25 countries involved in ocean energy development activities.
- Biomass heating markets are expanding steadily in Europe.
- The USA and Brazil accounted for 88 per cent of global ethanol production in 2009.

Source: Renewable 2010, Global Status Report, www.ren21.ne